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Study Current and Future Therapies in the Treatment of Cancer

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Abstract: Cancer is the second leading cause of death in the world. The most common types of cancer among men are: Pulmonary, prostate, colorectal, stomach, and hepatic, and the most common among women are breast, colorectal, pulmonary, cervical, and thyroid. The objective of this manuscript was to study current and future therapies in the treatment of cancer. Data were collected using a quantitative and descriptive approach, through books and the following databases: Scopus, SciVerse, Scientific Electronic Library Online, and the Academic Search Tool. The search was developed using the subject cancer, therapies, and treatment referred to in journals, through a review of the literature on the subject. In the initial search, the titles and abstracts of the articles were considered for the broad selection of likely works of interest, with the abstracts being highlighted.

Keywords: Cannabidiol, Chromosomes, Flavonoids, Genes, Metastasis, Mutation, Oxygen, Tumor.

Research Paper

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1.0. INTRODUCTION

According to the World Health Organization (WHO, 2025), "Cancer" is a broad term for illnesses that can originate in any organ or body tissue when abnormal cells grow, exceeding their usual limits and invading adjacent and/or spreading to other organs. This last process is called "metastasis" and is an important cause of disability due to cancer. Other common terms for cancer are "neoplasia" and "malignant tumor".

Cancer is the second cause of death in the world; In 2018, it caused 9.6 million deaths, or one out of every six. The most common types of cancer among men are: Pulmonary, prostate, colorectal, stomach, and hepatic, and the most common among women are breast, colorectal, pulmonary, cervical, and thyroid (WHO, 2025).

The burden of morbidity from cancer continues to increase throughout the world, and this generates enormous physical, emotional, and financial tension for families, communities, and health systems. Many health systems in countries with low and average incomes are very poorly prepared to manage this burden of morbidity, and a large number of cancer patients around the world lack timely access to quality diagnostics and treatment. In many countries, survival rates for various types of cancer are improving due to better access to early detection, healthcare, and care (WHO, 2025).

1.2. In the Americas Region

The most frequently diagnosed cancers in men are: prostate (21.8%), lung (8.6%), colorectal (7.7%), and bladder (4.5%). The most frequently diagnosed cancers in women are: breast (26.1%), lung (8.5%), colorectal (7.9%), and uterus (5.4%). The cancers that cause the most deaths in men are: lung (17.5%), prostate (13.3%), colorectal (9.6%), and pancreas (6.4%). The cancers that cause the most deaths in women are: breast (15.7%), lung (16.5%), colorectal (9.6%), and pancreas (6.6%) (PAHO, 2022; Santos *et al.,* 2023).

1.3. OBJECTIVOS

The objective of this manuscript was to study current and future therapies in the treatment of cancer.

2.0. METHODS

Data were collected using a quantitative and descriptive approach, through books and the following databases: Scopus, Scientific Electronic Library Online and Academic Search Tool. The search was developed using the subject cancer, therapies, and treatment referred to in journals, through a review of the literature on the subject. In the initial search, the titles and abstracts of the articles were considered for the broad selection of likely works of interest, with the abstracts being highlighted.

3.0. SELECTED STUDIES

3.1. Differences between cancer cells and normal cells. Cancer cells are very different from normal cells. For example:

1. Cancer cells originate without receiving the signals that they must form. Normal cells only form when they receive these signals.
2. Cancer cells do not have warning signs, cells that need to multiply, or cells that need to be destroyed. This process is called programmed cell death or apoptosis.
3. Cancer cells invade surrounding areas and spread to other areas of the body. Normal cells stop multiplying when they encounter other cells, and the majority of normal cells cannot move to other parts of the body.
4. Cancer cells cause blood vessels to grow towards tumors. These blood vessels bring oxygen and nutrients to the tumors and release tumor removal products.
5. Cancer cells hide from the immune system. The immune system can destroy damaged or abnormal cells.
6. Cancer cells trick the immune system to stay alive and multiply. Some cancer cells even allow immune cells to protect the tumor instead of attacking it.
7. Cancer cells incorporate numerous changes in their chromosomes, such as parts of the chromosome that are repeated or missing. Some cancer cells have double the normal chromosomes.
8. Cancer cells depend on nutrients. Furthermore, some cancer cells create energy from nutrients in different ways (Figure 1) (Yadav, 2023).

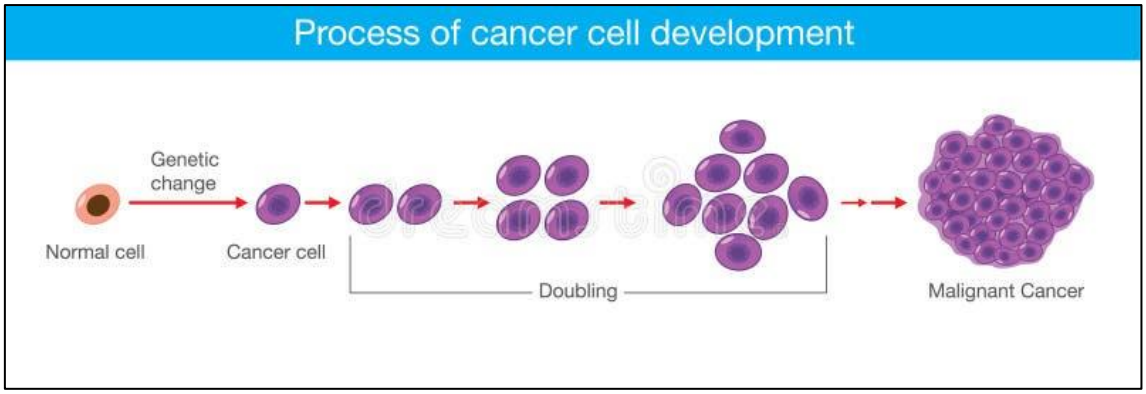

Figure 1: Process of cancer cell development

Sources: ID 72531182 - © Suriya Siritam\www. dreamstime.com, and https://www.dreamstime.com/stock-illustration-process-cancer-cell-development-medical-illustration-woman-touching-her-head-has-headaches-fever-image72531182

3.2. Cancer virology: Tumor cells and microenvironment

The project develops extensive basic and clinical research to understand, isolate, cultivate, and therapeutically use somatic and pluripotent stem cells. In addition to studying neoplastic stem cells associated with leukemia and lymphomas, the center is supported by three pillars: scientific research at the forefront of knowledge, dissemination of information to society, and technological innovation in collaboration with the productive sector (MCTI, 2008).

This view was replaced by the concept that cancer only begins with a restricted contingent of cells, the so-called Tumor Stem Cells (TSCs). These TSCs have specific characteristics that facilitate their isolation and characterization:

1. They are the only cells capable of originating in the tumor.
2. They have the capacity for self-renewal, that is, for maintaining the tumor.
3. They originate all the heterogeneous cellular progeny that constitute the tumor.
4. When transplanted into immunodeficient mice, these cells, and only these, are the original tumor with all its morphological and functional characteristics (MCTI, 2008).

It was demonstrated that only CD34+/CD38 cells in acute myeloid leukemia reproduce leukemia in mice, while CD34+/CD38+ cells did not. Since then, TSCs have been identified in several types of tumors, including breast, prostate, liver, colon, lung, skin, pancreas, and brain [1994-Lapidot *et al.*] (MCTI, 2008).

[Support Project: O Hemocentro de Ribeirão Preto, with support from Ministério da Ciência, Tecnologia, Inovações e Comunicações (MCTI), hosts for the second time an Instituto Nacional de Ciência e Tecnologia (INCT). O INCT in stem cells and cell therapy in cancer, coordinated by Prof. Dr. Dimas Tadeu Covas, expands the activities of the INCT in stem cells and cell therapy, created by CNPq/FAPESP in 2008].

3.3. Tumors

As a whole, they are heterogeneous masses of neoplastic and normal cells, associated with the

extracellular matrix to constitute a microenvironment conducive to the maintenance and proliferation of TSCs and their respective progeny (MCTI, 2008). The process by which normal cells become cancerous is called carcinogenesis. Understanding this process is the development of genetic study techniques (Sanche, 2013).

Through these, it was established that the progressive transformation of normal cells into highly malignant derivatives originated from alterations in the mutant genetic material. These mutations to divide at a higher rate than its cohort and generate descendants that retain this mutation clone. Subsequently, the daughter cells accumulate subsequent and diverse mutations (Hanahan and Weinberg, 2000; Mitrus *et al.,* 2012; Sanche, 2013).

3.4. Cancer

Cancer is exclusively caused and can be triggered by external and internal factors in our bodies. The vast majority of cases of cancer are associated with external factors, which include the environment and our lifestyle habits. Not only do we respect internal causes, but we can also highlight hereditary factors and immunological conditions. It is worth noting that some genetic factors are extremely important for the development of certain types of cancer, as they make people more susceptible to external agents (Figure 2) (UOL, 2025).

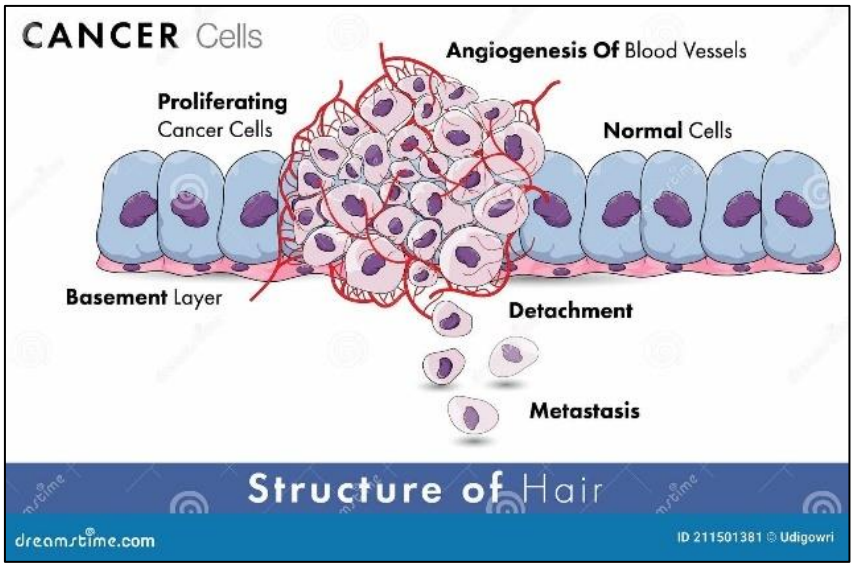

Figure 2: Cancer cell development is an entire mechanism, including angiogenesis, metastasis, and proliferation, with normal cells in the background

Sources: ID 211501381- © Udigowri | Dreamstime.com and https://www.dreamstime.com/cancer-cell-development-entire-mechanism-including-angiogenesis-metastasi-proliferation-normal-cells-background-image211501381

Cancer can be caused by internal factors, such as inherited mutations, hormones, and immune conditions, and by environmental factors, such as tobacco, diet, radiation, and exposure to infectious organisms. Some agents are known to cause cancer. Cigarettes, however, are an agent that can trigger malignant neoplasms, such as lung cancer. Also, excessive exposure to the sun may be responsible for skin cancer. Alcoholic beverages are also related to the development of some types of cancer, such as stomach and liver cancer. Do not forget that the HPV virus is also a developing cancer, especially uterine cancer (Malta *et al.,* 2017; Drope *et al.,* 2018; Masters *et al*., 2022; Campos *et al.,* 2024; UOL, 2025).

3.5. Protooncogenes

The protooncogenes participate in the normal formation and multiplication of cells. But when there are these genes or there is more normal activity, they can be converted into genes that cause cancer, called oncogenes. This causes cells to multiply and survive in cases where they cannot. Tumor suppressor genes also control the formation and multiplication of cells. Cells with certain changes in the tumor suppressor gene NDRG2 can multiply without control (Chen, 2025).

3.6. Deoxyribonucleic Acid (DNA)

DNA repair genes repair damaged DNA. Cells with mutations in these genes tend to exhibit more mutations in other genes and changes in their chromosomes, such as repeated or missing chromosome sections. When both mutations come together, the cells may become cancerous (Figure 3) (INC, 2021).

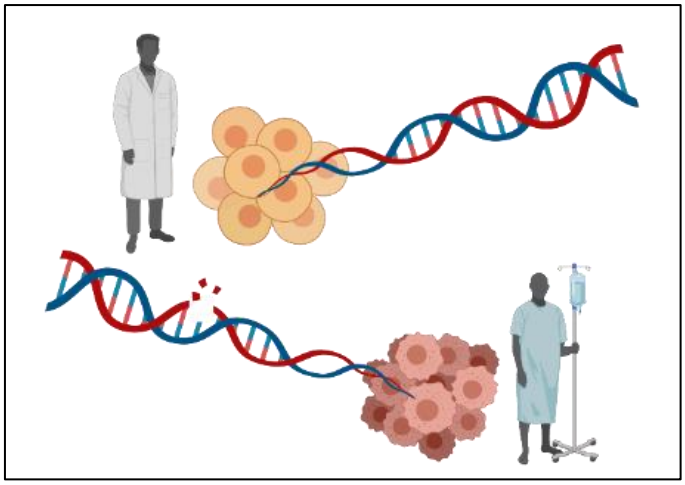

Figure 3: Genetics and cancer: An unlikely relationship between the duos
Source: https://thedishonscience.stanford.edu/articles/w31nkfkn3ollpkgvqhmd3b7fzntlst

3.7. Carcinogenicity

Carcinogenesis involves a slow process that can take years for a neoplastic cell to proliferate and give rise to a tumor. The different stages through which the tumor originates are:

1. Initiation stage:

Genes are affected by carcinogenic agents, which cause modifications in some of their genes. In this phase, the cells are genetically altered. They are "prepared", that is, "initiated" for the action of a second group of agents that will act in the next stage.

2. Promotion stage:

Genetically altered cells, that is, "initiated", are affected by carcinogenic agents classified as oncopromoters, such as food components, hormones, and tobacco. The initiated cell is transformed into a malignant cell slowly and gradually. Long and continuous contact with the promoting carcinogenic agent is necessary.

3. Progression stage:

Characterized by the uncontrolled and irreversible multiplication of the altered cells. At this stage, the cancer is already established, evolving until the first clinical manifestations of the disease appear (Barreto *et al.,* 1998; Portal Education, 2025).

3.8. Mutant cells:

1. They multiply disorderly and uncontrolled; that is, they divide more quickly than the normal cells of the surrounding tissue, and cell growth becomes continuous. Excessive cells gradually invade the entire organism, making the body sick.
2. The cells can detach themselves from the tumor and move. They initially invade neighboring tissues and may reach the inside of a blood or lymphatic vessel and, through these, spread, reaching organs far from the site where the tumor began, forming what we call metastases (Figure 4).

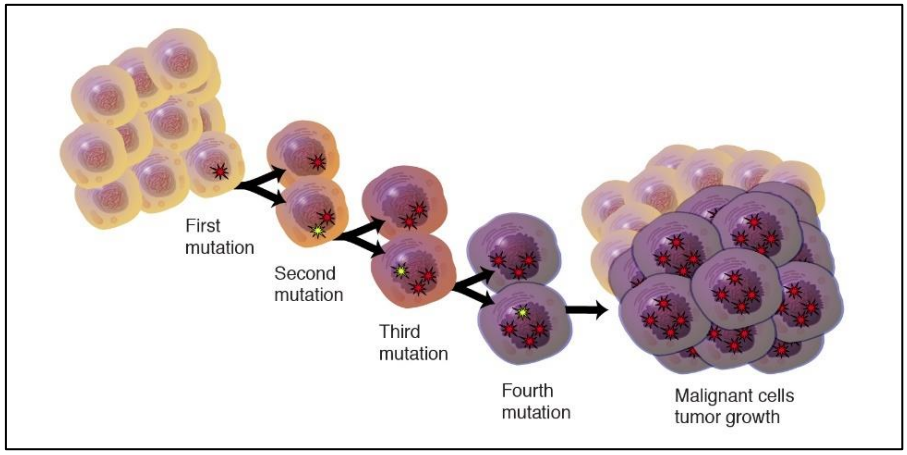

Figure 4: Mutations in cancer genes are inherited, which increases a person's risk of developing cancer
Sources: Elaine A. Ostrander, Ph.D., and https://www.genome.gov/genetics-glossary/Cancer

3. Cancer cells are generally less specialized in their functions than their normal counterparts. Cancer cells replace the normal cells, and the invaded tissues lose their functions (PAHO, 2022).

3.9. Regarding the cells where the process begins, the main categories are:

1. **Carcinomas:** They begin in the skin or in the tissues that line the organs. There are some subtypes, such as adenocarcinoma or basal cell carcinoma.
2. **Sarcomas:** They begin in cells of the bone, cartilage, fat, muscle, blood vessels, or other connective tissues.
3. **Leukemias:** They begin in immature cells of the bone marrow that give rise to the white blood cells, leukocytes of the blood. Depending on the type of cell affected, leukemia is classified as myeloid or lymphoid.
4. **Lymphomas:** These begin in lymphocytes, a type of white blood cell, and affect the lymphatic system. This cancer is divided into two main groups: Hodgkin and non-Hodgkin, and each of them has different subtypes.
5. **Myelomas:** These begin in plasma cells, a type of white blood cell (UOL, 2025).

3.10. Some general signs and symptoms associated with cancer, but not specific to this disease, include:

1. Fatigue.
2. A lump or thickened area that can be felt under the skin.
3. Weight changes, such as unintentional weight gain or loss.
4. Skin changes, such as yellowing, darkening, or reddening of the skin, sores that do not heal, or changes in existing moles.
5. Changes in bladder or bowel habits.
6. Persistent cough or shortness of breath.
7. Difficulty swallowing.
8. Hoarseness.
9. Persistent indigestion or discomfort after eating.
10. Persistent muscle or joint pain, without apparent cause.
11. Persistent fever or night sweats, without apparent cause.
12. Unexplained bleeding or bruising (MFMER, 2025).

3.11. Bases moleculares e celulares do tumor

3.11.1. Cell kinetics

In mitosis, cancer cells, particularly those of the bone marrow or lymphatic system, may have a shorter generation time, and there is usually a lower percentage of cells in the G0 stationary phase. Initial exponential tumor growth is followed by a plateau phase in which cell death equals the rate of daughter cell formation. The decreased proliferation rate may be related to exhaustion of the supply of nutrients and oxygen for rapid tumor expansion. When compared with larger tumors, smaller tumors have a higher percentage of active cells (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

3.11.2. Tumor growth and metastasis

The cellular kinetics of specific cancers is an important consideration in planning the treatment regimen with antineoplastic drugs and may influence dosing schedules and timing of treatment. As the cancer grows, nutrients are supplied by direct diffusion from the circulation. Local growth is facilitated by enzymes proteases that destroy adjacent tissues. As the tumor grows, it can release angiogenic factors, such as Vascular Endothelial Growth Factor (VEGF), which promotes the formation of new blood vessels needed for further growth (Figures 5-6) (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

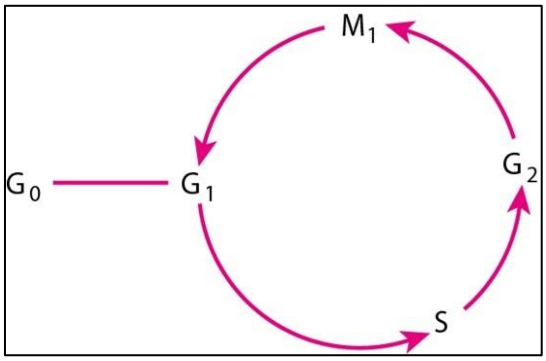

Figure 5: Cell cycle: G0 = resting phase non-proliferative cells; G1 = pre-DNA synthetic phase variable 12 h to a few days; G2 = post-DNA synthesis 2 to 4 h, tetraploid amount of DNA is found in the cells; M1 = mitosis 1 to 2 h; S = DNA synthesis in general, 2 to 4 h

Sources: MSD Manuals, Merck & Co., Inc., Rahway, NJ, USA and https://www.msdmanuals.com/pt/profissional/hematologia-e-oncologia/vis%C3%A3o-geral-sobre-c%C3%A2ncer/bases-moleculares-e-celulares-do-tumor

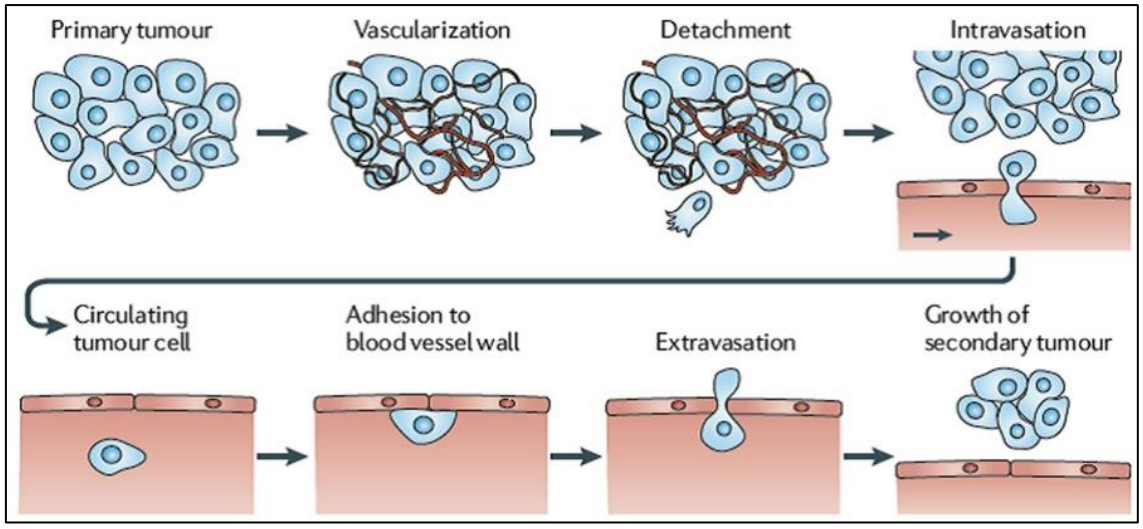

Figure 6: Cancer metastasis
Sources: 2025 HealthJade.com and https://healthjade.com/metastasis/

3.11.3. The immune system and cancer

Experiments suggest that the ability to invade, migrate, and successfully implant and stimulate the growth of new blood vessels is an important property of cells that cause metastases, which are likely to be a subset of primary cancers. The immune system and cancer: Cancer cells can express immune checkpoint proteins. Checkpoint proteins are cell surface molecules that signal to T cells that the cells expressing them are normal and should not be attacked (Figure 7) (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

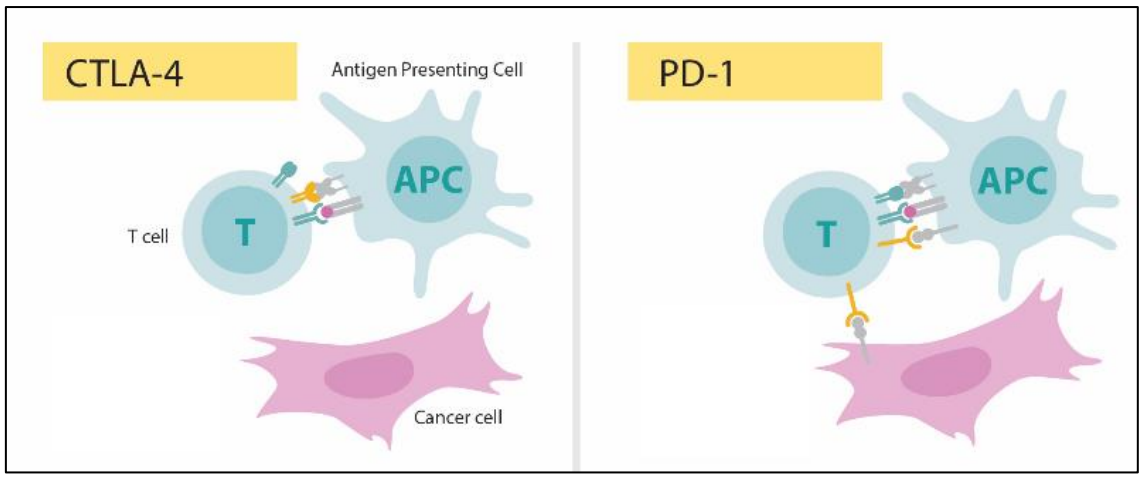

Figure 7: The two systems developed into therapies by today's Nobel winners
Source: Nobel Prize and https://arstechnica.com/science/2018/10/treatments-that-cause-the-immune-system-to-attack-cancer-earn-a-nobel/

One example is Programmed Cell Death-Ligand Protein 1 (PD-L1), which is recognized by the PD-1 molecule on T cells; when PD-L1 binds to PD-1 on a T cell, an immune attack is prevented. Cancer treatments using monoclonal antibodies called immune checkpoint inhibitors, which block PD-L1 or PD-1, allow the immune system to attack protected cancer cells. Cytotoxic T-lymphocyte-associated protein 4 (CTLA-4) is another immune checkpoint protein that prevents the immune system from attacking the cells and can also be blocked similarly by a specific antibody (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

3.11.4. Molecular abnormalities in cancer

Oncogenes are abnormal forms of normal genes (proto-oncogenes) that regulate cell growth and differentiation. Other oncogenes have been implicated in specific types of cancer. These include:

1. 1.HER2: Amplified in breast and gastric cancer and less commonly in lung cancer.
2. BCR: ABL1: A chimeric gene in chronic myeloid leukemia and some B-cell acute lymphocytic leukemias.
3. CMYC: Burkitt's lymphoma.

4. NMYC: Small cell lung cancer, neuroblastoma.
5. EGFR: Lung adenocarcinoma.
6. EML4ALK: A chimeric gene present in lung adenocarcinoma.
7. KRAS: Pancreatic cancer, lung cancer.

Specific oncogenes may have important implications for diagnosis, therapy, and prognosis (Gale, 2024). As with oncogenes, mutation of tumor suppressor genes such as TP53 or RB in germ cells can result in vertical transmission and a higher incidence of cancer in offspring. (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

Cancer cells often present neoantigens on their cell surfaces that can be detected as "non-self" by the immune system, resulting in an immune attack. The destruction of cancer cells can be complete, and cancer never appears. However, some cancer cells have or acquire the ability to avoid detection or destruction by the immune system, allowing them to proliferate (Gale, 2024).

Cancer cells can express immune checkpoint proteins. Checkpoint proteins are cell surface molecules that signal to T cells that the cells expressing them are normal and should not be attacked. In cancer treatment, monoclonal antibodies known as immune checkpoint inhibitors allow the immune system to attack protected cancer cells. Because immune checkpoint proteins can be present on normal cells, checkpoint protein inhibitor therapy may also induce an autoimmune response (Gale, 2024).

3.11.5. Tumor suppressor genes

Genes such as TP53, BRCA1, and BRCA2 play a role in normal cell division and DNA repair and are crucial in detecting signals of inappropriate growth or DNA damage in cells. These genes, as a result of acquired or inherited mutations, are unable to function; the system for monitoring DNA integration is inefficient, and cells with spontaneous genetic mutations persist or proliferate, resulting in tumors (Figure 8) (Baan *et al.,* 2009; Keeton *et al.,* 2017; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

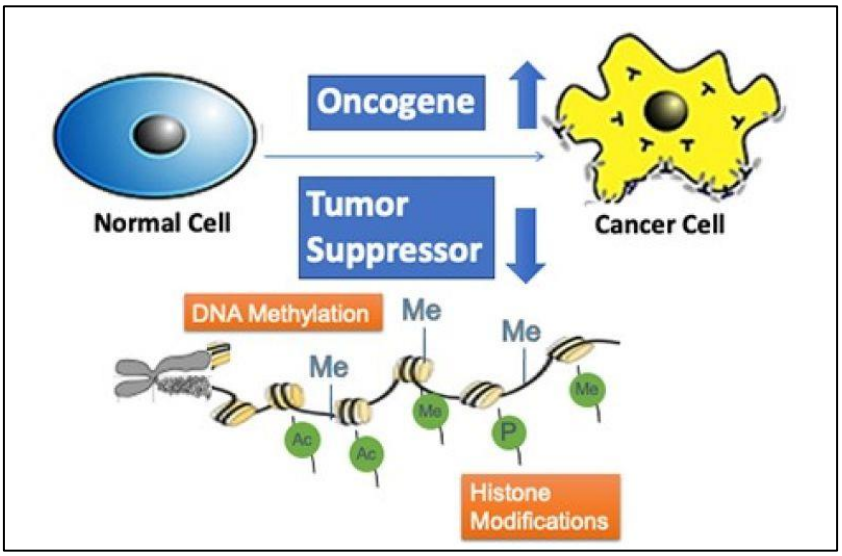

Figure 8: Tumor suppressor genes. New prediction algorithm identifies previously undetected cancer driver genes
Sources: U.S. National Science Foundation and https://www.nsf.gov/news/new-prediction-algorithm-identifies-previously

The important regulatory protein, p53, prevents the replication of damaged DNA in normal cells and promotes apoptotic cell death in cells with abnormal DNA. An inactive or altered p53 allows cells with abnormal DNA to survive and divide. TP53 mutations are passed on to daughter cells, conferring a high probability of error-prone DNA replication, and the result is neoplastic transformation. TP53 is defective in several types of human cancer. Mutations in BRCA1 and BRCA2 decrease function, increase the risk of breast and ovarian cancer (Baan *et al.,* 2009; Ribatti, 2017; Swann and Smyth, 2017; Gale, 2024).

3.11.6. Chromosomal abnormalities

1. Chromosomal abnormalities can occur by deletion, translocation, duplication, and other mechanisms. If these changes activate or inactivate genes that result in a proliferative advantage over normal cells, then cancer may develop (Figure 9) (Keeton *et al.,* 2017).

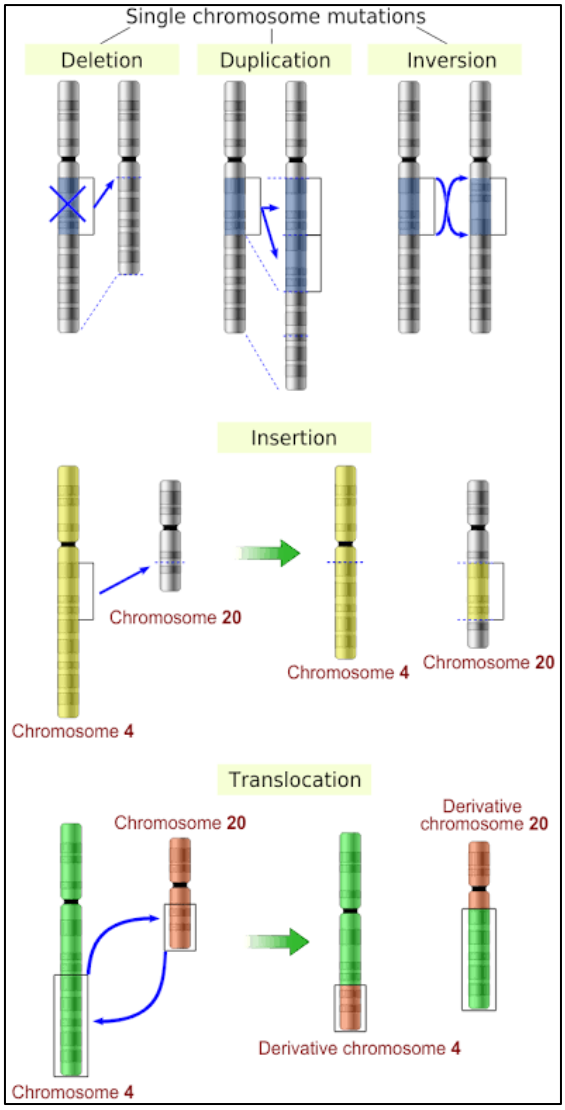

Figure 9: Chromosomal disorders in humans: structural changes, changes in chromosome number
Sources: Jahra Ayda and https://ar.inspiredpencil.com/pictures-2023/chromosomal-abnormalities

2. Telomeres are nucleoprotein complexes that cover the ends of chromosomes and maintain their integrity. In normal tissue, telomere shortening that occurs with age results in unlimited cell division. The enzyme telomerase, if activated in cancer cells, enables new synthesis of telomeres and allows continued tumor proliferation, causing skin, gastrointestinal, and bone marrow cancer (Keeton *et al.,* 2017).

3.12. Environmental factors in cancer

3.12.1. Infections

1. Viruses contribute to the pathogenesis of human tumors. These new genes are expressed by the host; they may affect cell growth or division. or disrupt normal host genes required for the control of cell growth and division. Conversely, viral infection may result in immune dysfunction, causing decreased immune surveillance for early tumors. HIV infection increases the risk of several cancers (Epstein-Barr virus, Human Papillomavirus, Human T-cell lymphotropic virus-1(HTLV-1), Kaposi's sarcoma-associated herpesvirus, and Merkel cell polyomavirus) (Parsonnet *et al.,* 1994; Baan *et al*., 2009; White *et al.,* 2014; Botelho and Richter, 2019).
2. Bacteria can also cause cancer. *Helicobacter pylori* (Goodwin *et al*., 1989) (Campylobacterales: Helicobacteraceae) infection increases the risk of several types of cancer (White *et al.,* 2014; Botelho and Richter, 2019).
3. Some types of parasites can cause cancer. *Schistosoma haematobium* and *Clonorchis sinensis* (Bilharz, 1852) (Platyhelminthes: Trematoda). cause chronic inflammation and fibrosis of the bladder, which can lead to cancer. *Opisthorchis* Blanchard, 1895 (Platyhelminthes: Trematoda) has been linked to carcinoma of the pancreas and bile ducts

(Parsonnet *et al.,* 1994; Baan *et al*., 2009; White *et al.,* 2014; Botelho and Richter, 2019).

3.12.2. Radiation

1. Ultraviolet radiation can cause skin cancer.
2. Ionizing radiation is carcinogenic: Exposure to X-rays and occupational radiation, or internal deposition of thorium dioxide.
3. Radon, a radioactive gas released from the ground, increases the risk of lung cancer, especially among smokers.

3.12.3. Medications and chemical agents

1. Oral contraceptives that combine estrogen and progestin.
2. Hormones: Estrogen, without progesterone.
3. Diethylstilbestrol (DES).
4. Long-term use of anabolic steroids.
5. Cancer treatment with chemotherapy or radiotherapy alone increases the risk of developing a second cancer, as do immunosuppressants administered for organ transplants (Parsonnet *et al.,* 1994; Baan *et al*., 2009; White *et al.,* 2014; Botelho and Richter, 2019).

3.12.4. Dietary substances

1. High-fat diet.
2. Alcohol intake.
3. Diet rich in smoked and preserved foods or meats cooked at high temperatures.
4. Overweight or obese people (Parsonnet *et al.,* 1994; Baan *et al*., 2009; White *et al.,* 2014; Botelho and Richter, 2019).

3.12.5. Physical factors

1. Chronic inflammation of the skin, lungs, gastrointestinal tract, or thyroid may predispose to the development of cancer.
2. Exposure to sunlight and tanning beds increases the risk of skin cancer and melanoma (Parsonnet *et al.,* 1994; Baan *et al*., 2009; White *et al.,* 2014; Botelho and Richter, 2019).

3.13. Fact sheet

3.13.1. Individually, they can contribute to reducing the burden of cancer. Individually, people can:

1. Talk to their doctor about their cancer risk and how to reduce it.
2. Participate in cancer screening and early detection programs.
3. Live a healthy lifestyle to reduce cancer risk.
4. Advocate for improved access to cancer screening and treatment services.
5. Share your experience or that of a loved one with cancer.
6. Support people with cancer.
7. Know that early detection and timely treatment save lives.
8. Physical exercises (Mohammadzadeh *et al.,* 2017; Ligebel *et al.,* 2022; PAHO, 2022).

3.13.2. Collectively, they can:

1. Prevent cancer.
2. Detect cancer early and improve outcomes.
3. Treat cancer effectively if detected in its early stages.
4. Create healthy public policies to reduce cancer risk factors.
5. Improve access to cancer care and cancer treatment.
6. Demonstrate the need to invest in cancer detection, treatment, and research.
7. Better understand the causes and risks of cancer and how to prevent them.
8. Train good professionals to fight cancer.
9. Educate the population to prevent cancer.

3.14. MAIN THERAPIES

3.14.1. Cancer treatment will depend on the type of tumor that a person presents, and also on the stage of development of the disease. In general terms, the main types are

1. **Chemotherapy:** The patient receives medications that destroy the tumor. These medications can be administered in different ways, but the main one is intravenous (IV) administration.
2. **Radiotherapy:** Based on the use of ionizing radiation, which will destroy the tumor or prevent its cells from multiplying.
3. **Surgery:** The cancer patient will undergo a surgical procedure based on the removal of the tumor from the body.
4. **Bone marrow transplant:** This procedure is used for patients with diseases that affect blood cells. It involves transferring normal bone marrow cells from a donor to the patient to replace the patient's bone marrow (IARC, 2019). Reducing social inequalities in cancer.
5. **Targeted Therapy:** Treatment that focuses on specific molecular targets present in cancer cells (BR, 2021; Yang *et al.,* 2024; UOL, 2025).

3.15. COMPLEMENTARY THERAPIES

3.15.1. Oxygen therapy

It is a therapeutic method for respiratory complications and shortness of breath, which works by replacing oxygen until it reaches a level above 90%, which is ideal for health. This treatment can be done using oxygen cylinders or concentrators. In addition to cancer treatments that aim to combat the tumor, such as chemotherapy and radiotherapy, other professionals, such as psychologists and nutritionists, play a role in the entire process (CPAPS.com.br, 2025). Oxygen therapy can also be part of these complementary treatments to increase the body's defenses, preventing the spread of the problem and the appearance of metastases (Yıldırım *et al.,* 2017; CPAPS.com.br, 2025).

Treatment with supplemental oxygen can increase the body's ability to recover and eliminate disease-causing microorganisms that can aggravate the cancer patient's condition. Thus, oxygen therapy strengthens the immune system, killing bacteria, fungi, parasites, and viruses along with deficient and diseased tissue cells. In addition, it increases the ability of healthy cells in the body to multiply (CPAPS.com.br, 2025).

This type of oxygen therapy is indicated for people who do not require large amounts of oxygen, and different devices can be used, such as:

1. Nasal catheter: Provide oxygen at 2 liters per minute.
2. Nasal cannula or goggle-type catheter: Provide oxygen up to 8 liters per minute.
3. Face mask.
4. Mask with reservoir: Capacity to store up to 1 liter of oxygen.
5. Tracheostomy mask (BHSC, 2025; Potter and Perry, 2017; Bezerra, 2024).

3.16. Hyperbaric oxygen therapy

1. Involves the administration of pure oxygen in a pressurized environment. Typically performed in Monoplace Oxy Hyperbaric Chambers, this treatment allows the patient to breathe oxygen at pressures higher than atmospheric, significantly increasing the amount of oxygen dissolved in the plasma.
2. Acts on several physiological and biochemical mechanisms that may be beneficial in the treatment of cancer.
3. Increased tissue oxygenation: Increases oxygenation of hypoxic tissues, which is a common condition in solid tumors.
4. Tumor hypoxia is associated with resistance to oxygen treatment and aggressive tumor progression.
5. Modulation of angiogenesis.
6. Can influence angiogenesis, a critical process for tumor growth.
7. Enhancement of radiotherapy.
8. Can increase the damage to the DNA of cancer cells during irradiation.
9. Applications for hyperbaric oxygen therapy in cancer treatment (Figure 10) (Oxy, 2024).

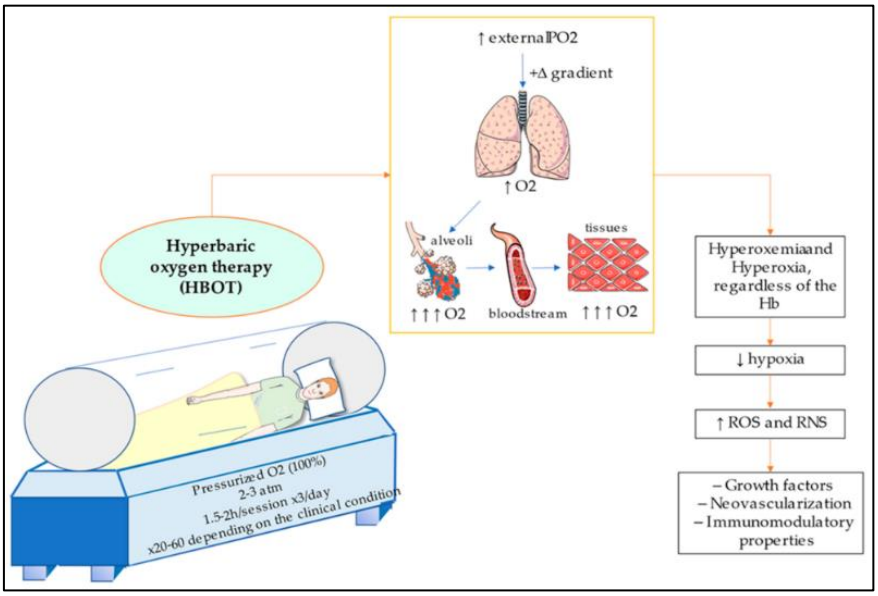

Figure 10: A general overview of the hyperbaric oxygen therapy: applications, mechanisms, and translational opportunities

Sources: Jahra Ayda and https://ar.inspiredpencil.com/pictures-2023/hyperbaric-oxygen-therapy-benefits

3.16.1. Main clinical applications

1. Head and neck cancer.
2. Has shown significant benefits when combined with radiotherapy, helping to reduce tumor hypoxia and improve response to treatment.
3. Radiation wounds.
4. Patients who have suffered tissue damage due to radiotherapy can benefit from hyperbaric oxygen therapy, which promotes wound healing and improves quality of life.
5. Surgical complications.
6. In cancer patients undergoing surgery, hyperbaric oxygen therapy can accelerate postoperative recovery, reducing the risk of infections and promoting tissue regeneration (Oxy, 2024).

3.16.2. The main benefits include

1. Improved quality of Life: Can help reduce the side effects of oncological treatments, such as radiotherapy-induced mucositis, improving the overall well-being of patients.

2. Reduced inflammation: Hyperbaric oxygen therapy ability to reduce inflammation may be particularly useful in cancer patients, where chronic inflammation is a contributing factor to disease progression.
3. Immune support: By improving oxygenation and reducing hypoxia, hyperbaric oxygen therapy can support immune function, helping the body fight tumor cells more effectively (Oxy, 2024).

3.16.3. Hospital oxygen therapy in adults and the elderly

This type of treatment aims to ensure the oxygenation of the body's tissues, indicated by the general practitioner or pulmonologist after checking the oxygen saturation in the blood through arterial blood gas analysis or pulse oximetry, which in normal situations is above 95%. Oxygen therapy increases the oxygen levels in the lungs and body tissues, reducing the negative effects of hypoxia. Understand what hypoxia is and the main symptoms. In general, oxygen therapy should be performed when the person has oxygen saturation below 95%, partial pressure of oxygen, or PaO2, less than 75 mmHg (BHSC, 2025; Potter and Perry, 2017; Bezerra, 2024).

3.17. Relationship between antioxidants and cancer

The system regulates Reactive Oxygen Species (ROS) levels and preserves redox balance in both organelles and the cytoplasm, extending into the interstitial fluid and blood to eliminate extracellular ROS. There are three primary antioxidant strategies for cellular protection against ROS damage:

1. ROS scavenging by low-molecular-weight molecules in intracellular and extracellular spaces.
2. Conversion of ROS into less reactive compounds by enzymatic antioxidants, thus reducing oxidation.
3. Sequestration of pro-oxidant transition metals, such as iron and copper, by chelating proteins, preventing their participation in ROS generation (Kim, 2019; Movahed *et al.,* 2021; Chai *et al.,* 2023; Sawada *et al.,* 2023; Kozlov *et al.,* 2024; Remigante *et al.,* 2024).

ROS are free radicals, which refer to a highly reactive atom or molecule that contains an odd number of electrons in its outermost electron shell, making it free. This configuration makes ROS molecules/ions highly unstable, with a short half-life and chemically very reactive. Reactive species can also be classified into 2 groups: Free radicals and non-radical compounds:

1. The free radical group includes superoxides, hydroxyl radical, nitric oxide, organic radicals, peroxyl, alkoxyl radicals, thiol radical, sulfonyl radical, thiol peroxide radical, and disulfides.
2. Non-radical ROS include hydrogen peroxide, singlet oxygen, ozone, trioxygen, organic hydroxides, hypochlorite, peroxynitrite, peroxynitroso carbonate anion, nitrocarbonate anion, nitrogen dioxide, and carbonyl derived from highly reactive carbohydrates or lipids (Liou and Storz, 2010; Birben *et al.,* 2012; Cotinguiba *et al.,* 2013; Xu *et al.,* 2014; Gouveia and Lima, 2017).

The consumption of foods rich in antioxidants is often encouraged as a way of preventing diseases. Since cancer is one of the leading causes of mortality in the world, several strategies have been proposed to reverse this situation. Thus, antioxidants would be an effective strategy for oxidative stress caused by ROS. As byproducts of cellular respiration, ROS function as secondary messengers in cell signaling, activating several receptors involved in cell survival, progression, migration, and invasion (Figure 11) (Snezhkina *et al.,* 2020; Jelic *et al.,* 2021; Majumder *et al.,* 2021; Reitz *et al.,* 2021; Nutritotal Pro, 2022; Masenga *et al.*, 2023).

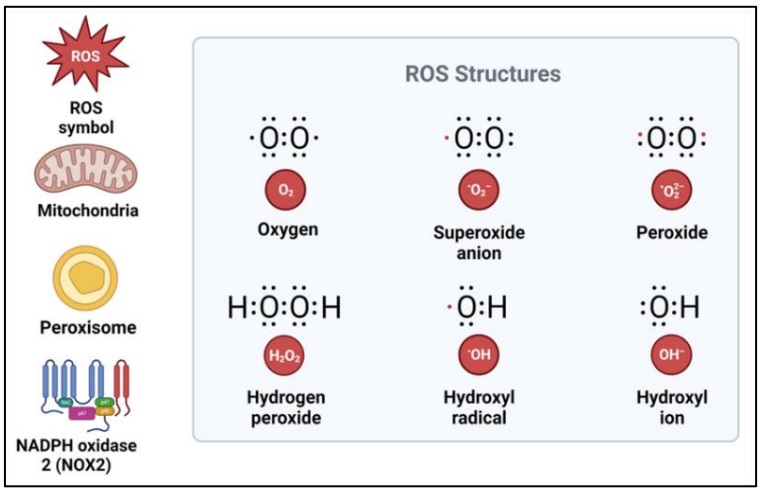

Figure 11: Structure of reactive oxygen species and their sources. ROS, Reactive Oxygen Species; NADPH, Nicotinamide Adenine Dinucleotide Phosphate; NOX2, NADPH oxidase
Source: Doi: 10.3390/ijms24097898

Although a minimum level of ROS is necessary for several physiological processes, its excessive production leads to oxidative stress. In this condition, several pathophysiological processes are facilitated, and cancer is one of them. In excess, ROS interacts with the following biomolecules, directly contributing to carcinogenesis:

1. Proteins: Cleavage of peptides, oxidative damage to amino acids, and protein dysfunction.
2. Lipids: Oxidative damage, leading to the loss of cell membrane properties.
3. RNA: Encoding imperfect proteins.
4. Genetic codifications: ROS can cause DNA mutations and damage to chromosomal structures, facilitating the transformation of normal cells into cancer cells.
5. DNA: Strand breaks, mutations, genetic instability, and epigenetic changes (Snezhkina *et al.,* 2020; Jelic *et al.,* 2021; Majumder *et al.,* 2021; Reitz *et al.,* 2021; Nutritotal Pro, 2022).

ROS also promotes chronic inflammation and the growth and survival of cancer cells through different strategies. The glycolytic pathway enables cancer cells with excess ATP to grow and divide in the oxygen-depleted microenvironment. ROS activates several cells signaling pathways, such as MAPK, PI3K-AKT, and NF-κB, which promote cell proliferation, survival, inflammation, and tumor invasion (Kim, 2019; Snezhkina *et al.,* 2020; Nutritotal Pro, 2022).

Several studies indicate that fruits and vegetables rich in antioxidants and bioactive compounds can protect humans from oxidative stress caused by ROS. Among the natural sources with high antioxidant potential, the following stand out: acerola, cashew, Formosa papaya, Hawaiian papaya, guava, pear, orange, and custard apple (Liou and Storz, 2010; Birben *et al.,* 2012; Cotinguiba *et al.,* 2013; Xu *et al.,* 2014; Gouveia and Lima, 2017).

In their article, Gouveia and Lima (2017) concluded that there are antioxidant molecules that are capable of stabilizing or deactivating ROS before they attack cells. These antioxidants can act in several mechanisms, such as capturing or regenerating free radicals, losing peroxides, eliminating O_2, and inhibiting enzymes involved in the process of free radical formation. There must be a balance between ROS and antioxidant levels, since both, at high levels, are harmful to the body. Therefore, it is necessary to determine the exact level of oxidative stress in an individual before prescribing antioxidant substances to combat ROS in the body (Gouveia and Lima, 2017).

Several natural antioxidants can act as primary antioxidants or free radical scavengers, and as secondary antioxidants or preventative antioxidants. Substances with the greatest antioxidant activity are phenolic compounds, which absorb and neutralize free radicals, and can be of natural or synthetic origin. Among the natural ones, vitamins A, E, and C stand out, widely found in fruits and vegetables, and which can hinder chain reactions, preventing damage caused by free radicals, in addition to carotenoids, flavonoids, among others, which are molecules that also act in the process of scavenging free radicals (Liou and Storz, 2010; Birben *et al.,* 2012; Cotinguiba *et al.,* 2013; Xu *et al.,* 2014; Gouveia and Lima, 2017).

3.17.1. The role of ROS in carcinogenesis and the therapeutic potential of polyphenols

Polyphenols, compounds found in fruits, vegetables, tea, and wine, are known for their antioxidant properties. However, in cancer cells, they can also act as pro-oxidants, increasing oxidative stress and inducing cell death. The article highlights several polyphenols with therapeutic potential:

1. Curcumin: Found in turmeric, curcumin can induce oxidative stress and apoptosis in several cancer cell lines, such as osteosarcoma and lung cancer. Studies show that curcumin can increase the efficacy of chemotherapy drugs such as cisplatin.
2. Caffeic acid: Found in coffee and various vegetables, caffeic acid can induce apoptosis in colon, breast, and chronic myeloid leukemia cancer cells. It is being studied in combination with bortezomib to increase antitumor efficacy.
3. Resveratrol: Grapes and red wine, resveratrol can induce apoptosis, autophagy and senescence in colon, ovarian, and breast cancer cells. It has shown potential in sensitizing cancer cells to treatments such as gemcitabine.
4. Podophyllotoxin: Extracted from plants such as podophyllum, podophyllotoxin inhibits microtubule assembly and topoisomerase II, inducing apoptosis in lung and colon cancer cells. Synthetic derivatives are being developed to improve bioavailability and reduce toxicity (Wang *et al.,* 2019; Liang *et al.,* 2021; Yuan *et al.,* 2023; Cordaro *et al.,* 2024; Seeds of Good Project, 2024).

The paper highlights the dual role of ROS in carcinogenesis and cancer therapy, emphasizing the need to balance ROS levels to prevent cellular damage and promote cancer cell death (Figure 12) (Rabelo *et al.*, 2021; Seeds of Good Project, 2024).

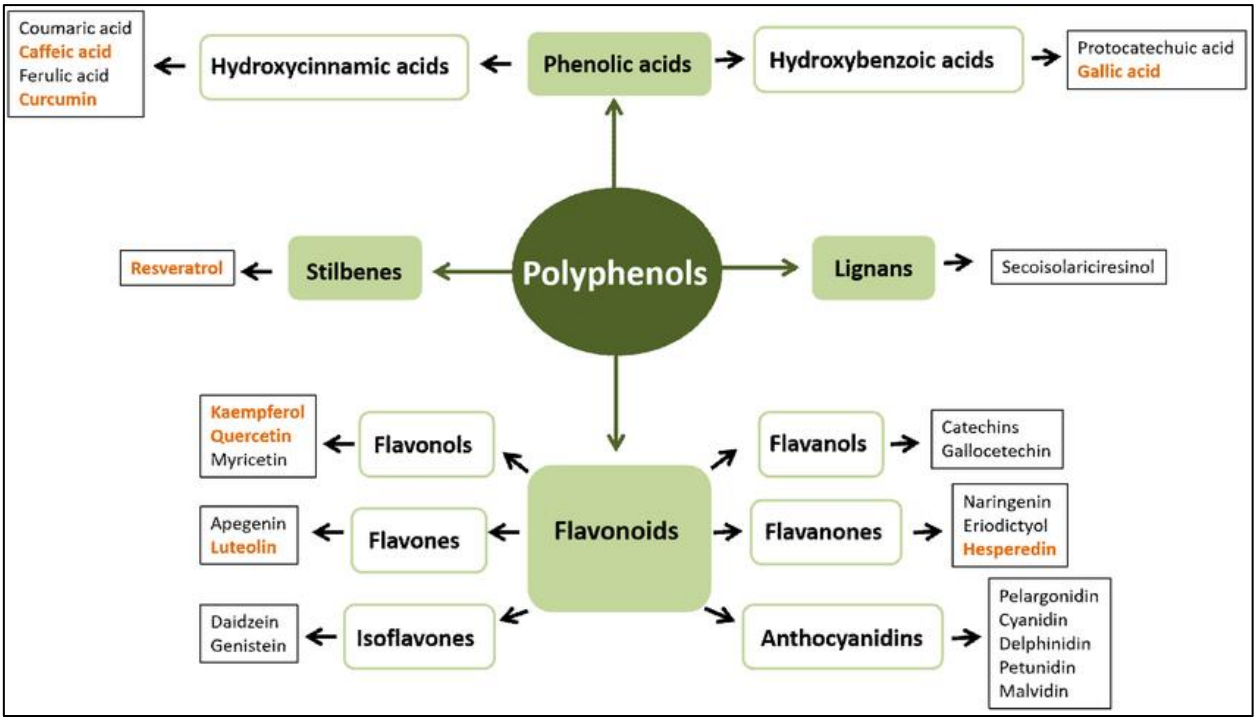

Figure 12: Main classes of polyphenols. The flavonoid class includes flavonols, flavones, isoflavones, flavanones, anthocyanidins, and flavanols. The non-flavonoid class contains more complex molecules, including stilbenes, lignans, and phenolic acids

Source: Doi:10.1111/jfbc.14026

Resveratrol is a polyphenol found in several foods, including grapes, mainly in the skins and seeds. One of the best-known sources of resveratrol is red wine. This compound has antioxidant, anti-inflammatory, and cardioprotective properties. Resveratrol acts as an activator of antioxidant enzymes, such as superoxide dismutase, and stimulates the expression of genes related to antioxidant defense. Resveratrol has anti-inflammatory properties that can help reduce the risk of cardiovascular and neurodegenerative diseases (Leonardi *et al.,* 2018; Movahed *et al.,* 2021).

The properties of quercetin-resveratrol and the importance of antioxidants for health. Antioxidants are substances free radicals, unstable molecules that can cause cellular damage. Oxidative stress, resulting from an imbalance between the production of free radicals and the body's ability to neutralize them, is associated with several diseases, including cardiovascular diseases, neurodegenerative diseases, and cancer (Chai *et al.,* 2023; Murugesan and Prabha, 2023; Sawada *et al.,* 2023; Remigante *et al.,* 2024).

3.18. Ozone therapy in cancer treatment

Ozone therapy is an alternative treatment that uses ozone (O_3), a highly reactive form of oxygen, to promote therapeutic benefits. In the context of cancer, ozone therapy is an area of growing interest; it is important to highlight that its use should be considered with caution and always in conjunction with conventional treatments. It is to emphasize that, despite these potential benefits, ozone therapy should not replace conventional and proven treatments for cancer, such as surgery, chemotherapy, and radiotherapy (Pina and Ribeiro, 2024).

3.18.1. Benefits that have been associated with ozone therapy during cancer treatment

1. Improved tissue oxygenation: Ozone can help improve tissue oxygenation, which can be beneficial in areas where oxygen supply is compromised due to cancer or treatment.
2. Improved oxygenation can help reduce resistance to treatment and improve the effectiveness of chemotherapy and radiotherapy.
3. Antioxidant properties: May contribute to a better immune response and help protect healthy cells from damage caused by conventional treatments.
4. Antimicrobial action: Helps prevent or treat infections, which are a common concern in cancer patients, especially those who have a compromised immune system.
5. Pain reduction: Relieves pain associated with cancer and its treatments, possibly due to its anti-inflammatory and analgesic properties.
6. Improves quality of life: Reduces symptoms such as fatigue, infections, and promotes general well-being (Pina and Ribeiro, 2024).
7. Improve cellular activity.
8. Activate the neuroendocrine system, significantly improving patients' quality of life.

9. Stimulate neurophysiological reactions that contribute to fighting tumors.
10. Improve cellular metabolism.
11. Mobilize stem cells (Cavalcante, 2021).

Medicinal ozone can generally be applied intravenously, intramuscularly, by rectal insufflation, and ozonated autohemotherapy. In localized tumors, it can also be applied through ozonated water. When it comes into contact with the body, ozone dissolves in the intracellular fluids, disappearing immediately after reacting with its organic compounds. Safely and immediately, the gas stimulates the body's defense systems, triggering a series of actions that, when combined, will provide the benefits mentioned above (Cavalcante, 2021).

3.19. Cannabidiol (CBD) Cancer: How CBD contributes to treatment

CBD in cancer patients is an area of constant development, with ongoing research to explore its effects and potential benefits. Cancer patients who choose to use CBD should always talk to their doctors before starting complementary treatment to find out how CBD may interact with other medications and therapies. However, studies show that using CBD in cancer patients can be safe and effective, offering a natural option to complement traditional treatment (Śledziński *et al.,* 2021; Medicina.in., 2024).

In the case of cancer, CBD can be used for prevention and treatment, either directly on the disease or on its symptoms. CBD is a cannabinoid that stands out for its therapeutic properties, being indicated for the treatment of several conditions and diseases. Among its effects, cannabidiol acts as a muscle relaxant, analgesic, anti-inflammatory, neuroprotective, and mood stabilizer. Specifically in the treatment of cancer, the effects of CBD range from symptom relief to antitumor properties (Śledziński *et al.,* 2021; Braun *et al.,* 2024; Cannabis & Health Portal, 2025).

Cancer can have a significant impact on a patient's quality of life and well-being. Fortunately, there are complementary and alternative therapies that can help improve the treatment experience, including the use of CBD. While research on the use of CBD in cancer patients is limited, studies suggest that CBD may help alleviate symptoms such as pain, nausea, and anxiety (Śledziński *et al.,* 2021; Medicina.in., 2024).

3.19.1. Key Takeaways:

1. CBD is a non-psychoactive compound found in the cannabis plant.
2. The use of CBD as a complementary therapy for cancer patients is a promising area of study.
3. CBD may help alleviate symptoms such as pain and nausea in cancer patients.
4. CBD oil is a popular compound.
5. Patients should always consult a healthcare professional before beginning the use of CBD as a complementary treatment for cancer (Śledziński *et al.,* 2021; Braun *et al.,* 2024; Medicina.in., 2024).

Using CBD during cancer treatment may not only provide relief from uncomfortable symptoms, but it may also help improve mood, reduce anxiety and depression, and increase feelings of well-being and quality of life:

1. Impact of CBD on cancer-related pain.
2. Relief from chemotherapy-induced nausea and vomiting.
3. Influence on quality of life in cancer patients.
4. CBD as emotional support for cancer patients (Braun *et al.,* 2024; Medicina.in., 2024).

Ongoing research suggests that CBD may play a role in increasing the effectiveness of other cancer treatments. Studies indicate that cannabidiol may enhance the effects of chemotherapy, making cancer cells more susceptible to chemotherapeutic agents. This synergy has been a focus of research, as it could lead to more effective and less debilitating treatment protocols (Figure 13) (Massi *et al*., 2013; Seltzer *et al.,* 2020; Śledziński *et al.,* 2021; More Skunk NGO, 2024).

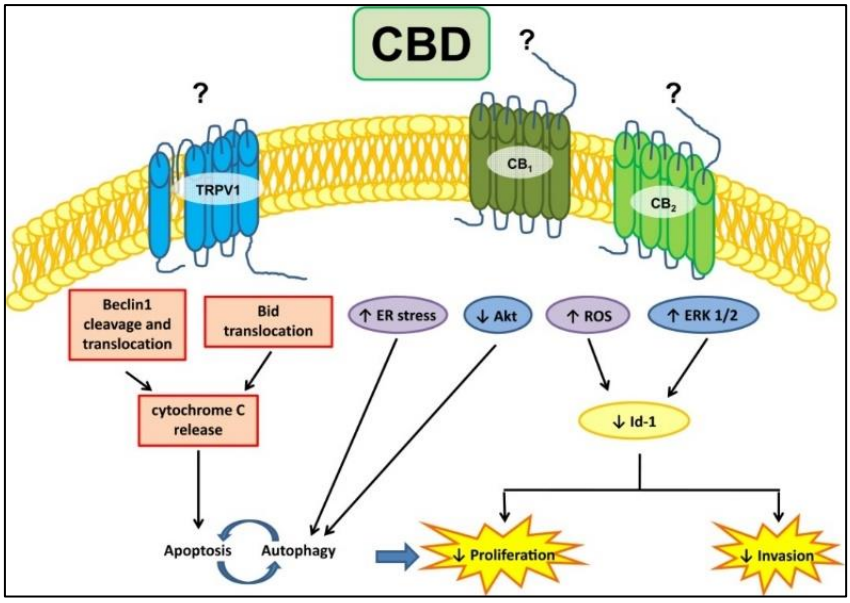

Figure 13: Schematic representation of the signalling pathways associated with CBD effects on breast cancer
Source: Doi: 10.1111/j.1365-2125.2012.04298.x

CBD may help reduce inflammation, which is a known contributor to the development and progression of cancer. Chronic inflammation is associated with many types of cancer, and by modulating this inflammatory response, CBD may play a preventative role. Research has shown that CBD can inhibit the migration of tumor cells and prevent angiogenesis, the process of new blood vessels feeding tumors. These properties make CBD a promising substance in oncology (More Skunk NGO, 2024).

Pain is often one of the main obstacles to cancer treatment. Patients also suffer from other side effects caused by chemotherapy and radiotherapy, such as nausea, vomiting, loss of appetite, anxiety, and depression, which worsen the patient's quality of life (Conte, 2022).

To manage these undesirable symptoms, the controlled use of opioid medications, such as morphine and its derivatives, is usually an effective solution. However, in recent years, medicinal cannabis has become popular and has become an alternative complementary therapy for patients. This is because we have cannabinoid receptors (CB1 and CB2 receptors endogenous to the endocannabinoid system) in our body that, when activated, interrupt the conduction of pain and inhibit inflammatory substances, causing an analgesic effect (Śledziński *et al.,* 2021; Conte, 2022).

CBD exerts, in a combined way, neuroprotective, anti-inflammatory, and anti-apoptotic effects, inhibiting Caspase 3 and acting on the toxicity of β-peptide, which may play an important role in neutralizing or slowing the progression of neuronal cell death. CBD has been emerging as a therapeutic agent in several pathologies such as cancer, anxiety, immunological diseases, and cardiovascular disease, because it presents high tolerability, low toxicity, and does not present psychoactive effects, in addition to presenting anti-inflammatory, antiepileptic and antioxidant activities (Zuardi, 2008; Pisanti *et al.,* 2017; Atalay *et al.,* 2020).

The range of applications of cannabidiol, although not yet approved by the medical community, is quite extensive. There is still much to learn about CBD for the treatment of cancer. However, we cannot ignore the most recent achievements of science (Braun *et al.,* 2024; Medicina.in., 2024).

3.20. Flavonoid: Quercetin

Quercetin is a polyphenolic flavonoid with antioxidant action, generally found in foods and astringents. Chemically, quercetin is an aglucone of rutin and other glycosides: flavonoids, and the number of phenolic radical hydroxyl substituents. The antioxidant activity of flavonoids has been the subject of study in recent years as it represents a major investment in the future development of drugs and other forms of treatment for various diseases, such as cardiovascular diseases, genetic diseases such as cancer, and degenerative diseases such as Alzheimer's and arthritis (Figure 14) (Li *et al.,* 2016; Parvaresh *et al.,* 2016; Tsuchiyae, *et al.,* 2022).

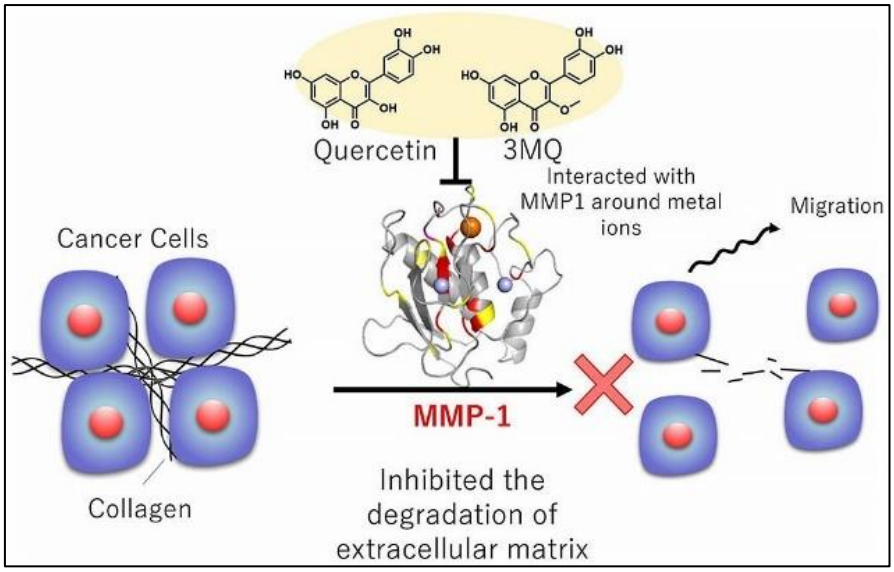

Figure 14: Mechanism of cancer migration inhibition by quercetin and its derivatives
Sources: Provided by Gifu University and Doi: 10.1016/j.bmc.2022.116854

Quercetin, which is attributed to its anticancer properties, its ability to reduce the incidence of coronary heart disease, its antidiabetic, antihistamine, antimicrobial, antimutagenic, neuroprotective, and vasoprotective properties (Pollard and Wolter, 2000; Asgharian *et al.*, 2022; Murugesan and Prabha, 2023).

3.20.1. Properties and functions

1. Prevent cancer.
2. Antioxidant properties.
3. Anti-inflammatory effect.
4. Strengthening the immune system.
5. Chronic inflammation.
6. Modulation of oxidative stress markers and antioxidant enzymes.
7. Reduction of tumor proliferation.
8. Induction of apoptosis and autophagy.
9. Inhibition of mitotic events.
10. Inhibition of metastasis.
11. Chelating agent.
12. Powerful antiviral (Pollard and Wolter, 2000; Li *et al.,* 2016; Parvaresh *et al.,* 2016; Asgharian *et al.*, 2022; Murugesan and Prabha, 2023).

The properties of quercetin resveratrol make it important to understand the importance of antioxidants for health. Antioxidants are substances capable of neutralizing free radicals, unstable molecules that can cause cellular damage. Oxidative stress, resulting from an imbalance between the production of free radicals and the body's ability to neutralize them, is associated with several diseases, including cardiovascular diseases, neurodegenerative diseases, and cancer (Pollard and Wolter, 2000; Li *et al.,* 2016; Parvaresh *et al.,* 2016; Asgharian *et al.*, 2022; Murugesan and Prabha, 2023).

3.21. Articles

3.21.1: Effects of ozone treatment on health-related quality of life and toxicity induced by radiotherapy and chemotherapy in symptomatic cancer patients

The ozone therapy procedures did not present complications. The clinical effect was observed in the improvement of appetite, sleep, and relief of nausea and weakness. All patients with elevated bilirubin, fibrinogen, and liver enzyme activity after ozone therapy treatment showed a return of these indices to baseline values. The initial laboratory results showed an increase in total blood antioxidant activity and inhibition of lipid peroxidation processes. Considering the property of ozone in low concentrations to improve immunity and lipid peroxidation, ozone was used as a polyactive remedy. Ozone therapy has proven to be very useful in the treatment of complications of chemotherapy in patients with oncogynecological pathologies (Kontorschikova *et al.,* 2017; Hong *et al.,* 2024).

The main side effects induced by chemotherapy or radiation are: oxidative stress, inflammation and ischemia. The main mechanisms of action of ozone treatment involve an adaptive response of the organism, leading to improved modulation of oxidative stress by increasing NRF2, a subsequent anti-inflammatory effect associated with modulation of pro-inflammatory cytokines, and modulation of blood flow with potential reduction of ischemia/hypoxia (Figure 15) (Cavalcante, 2021; Clavo *et al.,* 2023; Philozon, 2025).

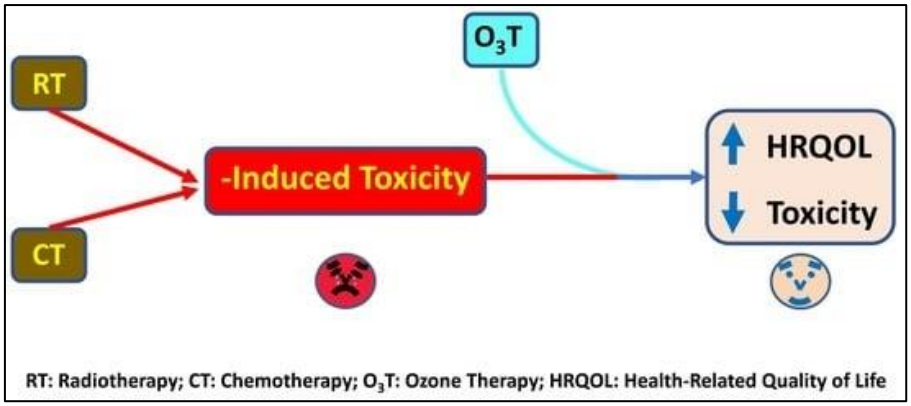

Figure 15: In cancer survivors with chronic side effects of cancer treatment, ozone treatment can improve the grade of toxicity and the adverse impact on their Health-Related Quality of Life (HRQOL)
Source: Doi: 10.3390/ijerph20021479

The impact of ozone therapy treatment on health-related quality of life and toxicity in cancer patients treated in a chronic pain unit was evaluated. Twenty-six cancer patients completed the health-related quality of life assessment before and after ozone therapy. Ozone therapy was administered to 15 patients affected by chemotherapy-induced neuropathy and to 11 patients with radiation-induced side effects. Ozone treatment procedures focus on the systemic use of ozone rectal insufflation, with ozone exposure of the injured area, cutaneous or intravesical wounds (Clavo *et al.,* 2023).

After ozone treatment, the changes in all patients ($n = 26$) were statistically significant. Treatment, there was a significant improvement ($p < 0.001$) in the EQ-5D-5L index of the patients' health status results. All dimensions of the EQ-5D-5L questionnaire, mobility, self-care, activities, pain/discomfort, anxiety/depression, and the self-assessment of health status through the visual analogue scale improved significantly ($p < 0.05$). The degree of toxicity also decreased significantly ($p < 0.001$). According to Calvo *et al.* (2023), ozone therapy can improve the degree of toxicity and quality of life. These results deserve further research. Other studies are ongoing.

3.21.2. Ozone therapy in integrated cancer management - Brazilian Association of Ozone Therapy (BAOT, 2025). (Hosted Abstract). Proceedings of the 5Th WFOT Meeting; 2016 Nov 18-20; Mumbai, India

The best results have been a combination of personalized health, ozone therapy, parenteral nutrients, oral nutrients, and other conventional treatments. We have simultaneously high doses of vitamin C and Major Autohemotherapy (MAHT) in more than a hundred cases, with much better results than any other mode of conventional and alternating therapy (Reekumar, 2018).

High doses of Vitamin C with ozone therapy have given better results than chemotherapy protocols because of the link between oxygen and cancer. The researcher Dr. Otto Warburg (1931 - 1944), on average, 60% oxygen deprivation in a cell will cause stress leading to oxidation/reduction disorders and uncontrolled cell division. We have experience in more than 100 cancer cases in the last two years (Reekumar, 2018). Thus, in the integrated approach to cancer treatment, ozone therapy has a very important and decisive role in maintaining a high quality of life and health (Reekumar, 2018).

3.21.3. Earwax in the fight against cancer: A technique developed by UFG researchers revolutionizes early diagnosis

The study, published in the journal Scientific Reports, published by Editora Nature, is led by Nelson Roberto Antoniosi Filho, professor of the Graduate Program in Chemistry (PPGQ/UFG) and the Graduate Program in Environmental Sciences (PPGCIAMB/UFG), and coordinator of the Extraction and Separation Methods Laboratory (LAMES). The research also includes the following researchers from UFG: João Marcos Gonçalves Barbosa, PhD from PPGQ, Camilla Gabriela de Oliveira, master's student in the Graduate Program in Health Sciences (PPGCS/UFG), and Anselmo Elcana de Oliveira (Figure 16).

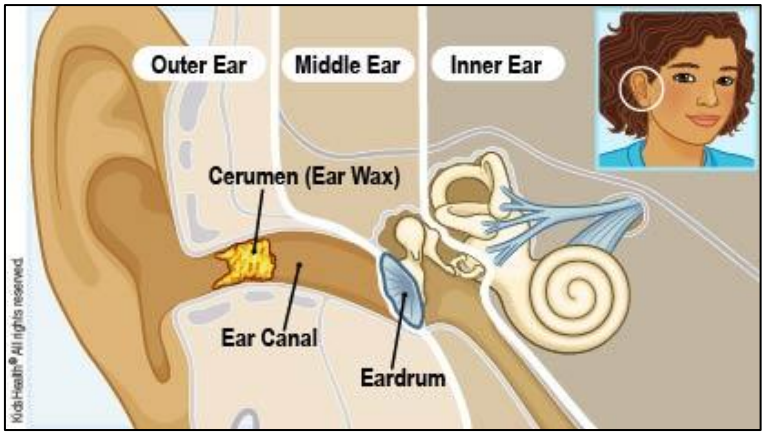

Figure 16: Earwax has some important jobs. It is a waterproof lining of the ear canal, protecting it and the eardrum from germs that can cause infection, trapping dirt, dust, and other particles, keeping them from injuring or irritating the eardrum

Sources: The Nemours Foundation, Getty Images, Nemours Foundation, and https://kidshealth.org/Inova/en/parents/earwax.html?WT.ac=pairedLink

Researchers have developed the Cerumenogram, a method that allows the identification of cancer, diabetes, Alzheimer's, and Parkinson's, with the potential to transform preventive medicine in the country. In addition to diagnosing the disease, the Cerumenogram allows the distinction between benign and malignant tumors, detecting pre-cancerous stages, and monitoring the response to treatment. "When we can diagnose cancer in its first stage, we have a 90% to 95% chance of curing the person. Now, with detection being possible in two stages before the first stage, the chances of cure are much higher" [Dr. Nelson Roberto Antoniosi Filho] (UFG Post, 2021; Barbosa *et al.,*2025).

Earwax has been identified as the source of volatile mitochondrial metabolites derived from ROS for the study of metabolic disorders in the human body, mainly due to its ability to concentrate polar and nonpolar compounds excreted by the sebaceous and sweat glands. In recent years, we have explored Headspace/Gas Chromatography-Mass Spectrometry (HS/GC-MS) assays using earwax as a biofluid for veterinary investigations. In recent studies, we have demonstrated that earwax metabolites can discriminate between cancer and non-cancer control cohorts in humans and dogs (UFG Post, 2021; Barbosa *et al.,*2025).

3.21.4. Researchers synthesize nanoparticles that can treat cancer

A group of researchers from the Physics Institute of the Federal University of Goiás (UFG), led by Professor Andris Bakuzis, has synthesized a magnetic nanoparticle made of materials called theranostics, with simultaneous applications in cancer treatment and diagnosis, with minimal toxicity, which is generating great expectations for future applications. "We are further improving this system to conduct in vivo studies, including in a metastatic tumor model," emphasizes the researcher. The research is being conducted with the Thermal Nanomedicine Center, a project funded by the Goiás State Research Support Foundation (FAPEG).

The team developed a multifunctional nanocarrier based on iron oxide doped with zinc and manganese for use in the treatment of Magnetic Hyperthermia (MH) in clinical conditions – an oncological treatment that uses heat to destroy target cancer cells. The heat in MH is generated by nanoparticles when subjected to the action of an alternating magnetic field. The nanoparticles were coated with silica and contain Neodymium (Nd) ions in their matrix. The multifunctional magnetic nanoparticle can generate and monitor heat in real time during thermal therapy. The size of the nanocarrier is around 100 nm, much smaller than the thickness of a strand of hair (approximately 50,000 nm). 1 nm is 1 billion times smaller than 1 meter (1nm = 10-9 m) (Yallapu *et al.,* 2012; Vinícius-Araújo *et al.,* 2021; UFG Journal, 2021).

The researcher says: "The magnetic field interacts with magnetic nanoparticles and generates heat. Laser, with the ability to penetrate a certain depth inside the patient's body, interacts with the NPs and generates heat. The heat increases the temperature and kills tumor cells. This same heat can be used to activate the immune system. The group is working to develop nanoparticles that do this efficiently, even thinking about treating metastatic patients" [Andris Bakuzis]. Thermal nanotherapies, in principle, are useful for any type of cancer (Vinícius-Araújo *et al.* 2021; UFG Journal, 2021).

3.22. NEW CANCER THERAPIES

3.22.1. Food and Drug Administration (FDA) - Main types of immunotherapies

1. Block signals that normally "turn off" T cells.
2. Allow the immune system to recognize and attack the cancer.
3. Administered intravenously.

4. Examples include drugs that block PD-1, PD-L1, and CTLA-4.
5. Immune Checkpoint Inhibitors (Medicine Consultation, 2025).

3.22.2. CAR T-Cell Therapy - Particularly effective in certain blood cancers

1. Removes T cells from the patient.
2. Genetically modified them in the laboratory.
3. Reintroduces the modified cells to attack the cancer (Medicine Consultation, 2025).

3.22.3. Cancer Vaccines

1. Stimulate specific immune responses.
2. Target specific tumor antigens.
3. Cytokines (Medicine Consultation, 2025).

3.22.4. Proteins that act as messengers of the immune system

1. Help boost the immune response.
2. Advances in Immunotherapy (Medicine Consultation, 2025).

3.22.5. Immunotherapy has revolutionized the treatment of several types of cancer, including:

1. Advanced melanoma.
2. Non-small cell lung cancer.
3. Kidney cancer.
4. Bladder cancer.
5. Head and neck cancer.
6. Hodgkin lymphoma.
7. Targeted therapies are another promising frontier in cancer treatment. They work by identifying and attacking specific characteristics of cancer cells, such as genetic mutations or overexpressed proteins, that drive tumor growth and survival (Medicine Consultation, 2025).

3.22.6. How they work:

1. Kinase inhibitors: Block enzymes, kinases that signal cancer cells to grow and divide.
2. Monoclonal antibodies: Lab-designed proteins that bind to specific targets on the surface of cancer cells, marking them for destruction by the immune system or blocking growth signals.
3. Angiogenesis inhibitors: Prevent the formation of new blood vessels that tumors need to grow.
6. Their big advantage is precision: B3y targeting cancer cells, they tend to spare normal cells, which can result in different side effect profiles than chemotherapy (Medicine Consultation, 2025).

3.22.7. Managing immunotherapy side effects - Common effects on different organs

1. Skin: Rash and itching.
2. Digestive system: Inflammation of the colon and diarrhea.
3. Lungs: Inflammation of the lungs.
4. Endocrine system: Thyroid problems and hypophysitis.
5. Liver: Hepatitis (Medicine Consultation, 2025).

3.22.8. Appropriate management of these side effects is essential and includes:

1. Constant monitoring of symptoms by the patient and the medical team.
2. Early detection and accurate diagnosis.
3. Use of immunosuppressive medications such as corticosteroids when necessary.
4. Regular medical follow-up and open communication (Medicine Consultation, 2025).
5. **3.23. New cancer therapies - The Sistema Único de Saúde (SUS) – Brazil (2025)**

Technological innovations cover different types of cancer, ranging from new drug therapies to advances in diagnosis and treatment, including:

1. **Multiple myeloma:** The drug carfilzomib is an option for patients who do not respond to initial treatment, offering new perspectives for controlling the disease.
2. **Chronic lymphocytic leukemia**: The combination of chemotherapy with rituximab strengthens patients' immunity, improving response to treatment.
3. **Skin cancer:** Photodynamic therapy, developed in Brazil, represents an innovative approach to the most common type of cancer in the country.
4. **Lung cancer:** Advanced technologies, such as positron emission tomography (PET) and RT-PCR, allow the identification of genetic mutations and the mapping of the stage of the disease. In addition, durvalumab offers new therapeutic possibilities for advanced stages.
5. **Ovarian and cervical cancer:** molecular testing for HPV and the drug olaparib are significant advances for the early diagnosis and treatment of advanced cases (Oncoguia Portal, 2025).

3.24. New cancer therapies - Cancer: check out the treatments that have advanced the most in 2024 (Oncoclínicas & Co., Brazil)

1. Among the most promising developments, new immunotherapy modalities stand out, including antibodies conjugated to drugs and therapeutic vaccines with mRNA technology. CAR-T cell therapy, already approved for hematologic cancers, presents encouraging results, and studies are underway for solid tumors.
2. Precision therapies, based on the specific genetic analysis of tumors, increase efficacy and reduce side effects (Nunes, 2024).

3.25. New cancer therapies - News in Cancer Treatments in 2025

1. Skin cancer:

The third phase of the vaccine study is being conducted with British patients. The injection uses a technique similar to mRNA technology. It is adapted according to the cells of each individual and has the potential to also be used in the prevention of lung, kidney, and bladder cancers [Pharmaceutical companies Moderna and Merck/MSD].

2. Lung cancer:

Immunotherapy, in combination with chemotherapy and radiotherapy, increased the life expectancy of patients [Oncologist Igor Morbeck, from Oncoclínicas Brasília].

3. Breast cancer:

Triple-negative breast cancers are very difficult to treat due to their aggressiveness. Studies have shown that immunotherapy with pembrolizumab before surgery increased the chances of remission [Oncologist Gustavo Fernandes, national director of Oncology at Rede Dasa].

4. Esophageal cancer:

Treatment with chemotherapy followed by surgery showed better results compared to the standard treatment of chemoradiotherapy followed by surgery [Oncologist Morbeck].

5. Improvement in patient weight and disposition:

Ponsegromab is a monoclonal antibody that inhibits the circulating cytokine GDF-15, which tends to be found in very high levels in cases of cancer-related cachexia. The use of the drug has shown improvement in weight, appetite, and energy for exercise

6. Target therapy:

The therapy is highly precise and can increase the effectiveness of its combat by weakening the tumor, as it divides it into smaller parts (Figure 17) (Rodrigues, 2025).

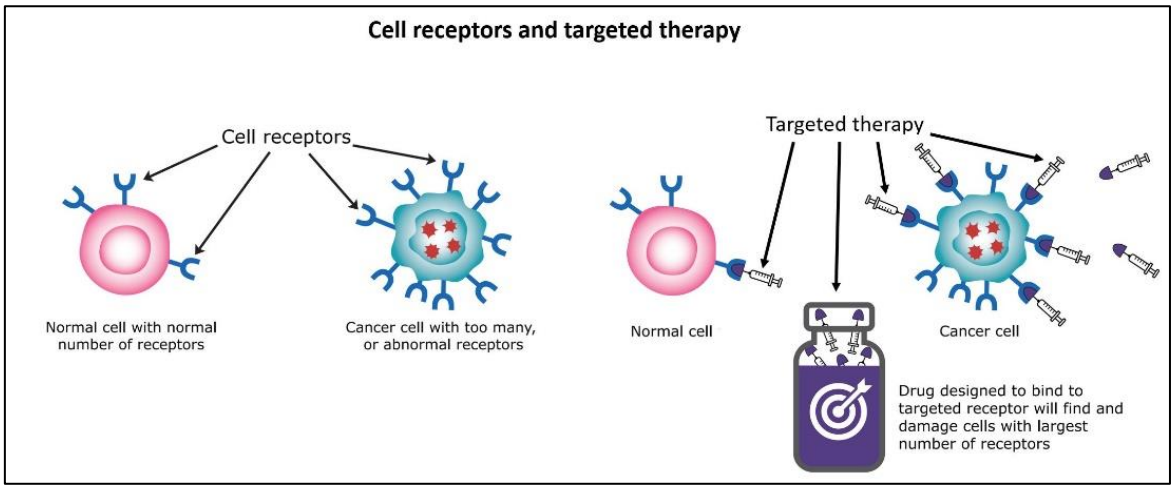

Figure 17: Targeted therapies are designed to attack or kill cancer cells while sparing as many normal cells as possible. These therapies are often designed to bind to abnormal proteins, receptors, or genes found in large quantities on cancer cells or in surrounding tissue

Sources: https://www.facingourrisk.org/info/risk-management-and-treatment/cancer-treatment/by-treatment type/targeted-therapy/overview

3.26. New cancer therapies - Technological advances in oncology future

1. **Precision Medicine:** Precision medicine, also known as personalized medicine, uses genetic information, biomarkers, and individual characteristics of patients to develop specific treatments. This method allows oncologists to choose therapies that are most effective for the specific type of cancer and genetic profile of the patient, increasing the chances of treatment success.
2. **Immunotherapy:** Immunotherapy is a revolutionary advance that harnesses the patient's immune system to fight cancer. Unlike traditional treatments that directly attack cancer cells, immunotherapy stimulates the immune system to recognize and destroy cancer cells more effectively. This approach has shown promising results in several types of cancer, including melanoma and lung cancer.
3. **Targeted therapies:** Targeted therapies are drugs that specifically identify and attack the molecular changes that allow cancer to grow and spread. These therapies have fewer side effects compared to traditional chemotherapy because they primarily target cancer cells, sparing healthy cells.
4. **High-Precision Imaging:** Advances in imaging technology, such as high-definition Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and Computed Tomography (CT), enable more accurate and detailed diagnoses. These technologies help doctors more accurately locate tumors, assess

the extent of the disease, and monitor the response to treatment in real time.

5. **Robotic Surgery:** Robotic surgery is an innovation that is improving the precision of surgical interventions. With the help of surgical robots, surgeons can perform complex procedures with greater precision and control, resulting in fewer complications, shorter recovery times, and smaller scars for patients.
6. **Artificial Intelligence (AI) and Big Data:** AI and Big Data are revolutionizing oncology by providing tools for analyzing large volumes of genomic and clinical data. These technologies help identify patterns and predict responses to treatments, further personalizing therapeutic approaches and improving outcomes.
7. **Telemedicine and Digital Health:** Telemedicine and digital health technologies are facilitating access to cancer treatment and follow-up. Patients can consult with their doctors remotely, access their medical records online, and use apps to monitor symptoms and treatment adherence, making care more accessible and convenient (Lissa, 2025; Rodríguez, 2025).

4.0. CONCLUSION

As advances in the field of cancer treatment are made, it is clear that therapies such as: Oxygen, targeted, antioxidants, ozone, cannabidiol, flavonoids quercetin, vitamin C with ozone, Cerumenogram, nanoparticles, and future therapies such as immunotherapies, vaccines, and technology, such as high-definition magnetic resonance imaging, positron emission tomography, computed tomography, enable more accurate, detailed diagnoses, robotic surgery, artificial intelligence big data, telemedicine and digital health Medicine presents significant challenges that persist, such as resistance to treatments, differences in patient responses and their financial limitations can affect the effectiveness of these current and future therapies. Therapies must adapt and evolve to meet the treatment needs of patients.

REFERENCES

- Asgharian, P. *et al.* (2022). Potential mechanisms of quercetin in cancer prevention: focus on cellular and molecular targets. *Cancer Cell International, 22*, 257.
- Atalay, S., Jarocka-Karpowicz, I., & Skrzydlewska, E. (2020). Antioxidative and anti-inflammatory properties of cannabidiol. *Antioxidants, 9*, 21.
- Baan, R. *et al.* (2009). A review of human carcinogens—Part F: Chemical agents and related occupations. *Lancet Oncology, 10*(12),1143-1144.
- Barbosa, J. M. G. *et al.* (2025). Cerumenogram as an assay for the metabolic diagnosis of precancer, cancer, and cancer remission. *Scientific Reports, 15*, 13929.
- Barreto, M. L. *et al.* (1998). Epidemiology, services, and technologies in health. Rio de Janeiro: Editora FIOCRUZ.
- Bezerra, C. (2024). Oxygen therapy: what it is, types, what it is for, and precautions. Your Health. Retrieved May, 25, 2025, from https://www.tuasaude.com/oxigenoterapia/#google_vignette
- Birben, E., Sahiner, U. M., Sackesen, C., Erzurum, S., & Kalayci, O. (2012). Oxidative stress and antioxidant defense world. *Allergy Organization Journal, 5,* 9-19.
- Botelho, M. C., & Richter, J. (2019). Editorial: Parasites and cancer. *Frontiers in Medicine*, *6*, 55.
- Braun, I. M. *et al.* (2024). Cannabis and cannabinoids in adults with cancer: ASCO Guideline. *Journal of Clinical Oncology, 42*(13), 1575-1593.
- Brazilian Association of Ozone Therapy (BAOT) (2025). Ozone therapy in integrated cancer management. Retrieved May, 28, 2025, from https://www.aboz.org.br/biblioteca/ozone-therapy-in-integrated-cancer-management-/129/
- Brazilian Hospital Services Company (BHSC). (2025). Hospital oxygen therapy in adults and the elderly. Retrieved May, 25, 2025, from <http://www2.ebserh.gov.br/documents/147715/0/POP+19+Oxigenoterapia+hospitalar+aprovado.pdf/ccd04e6e-2aa9-4f59-a8a3-ac7b3eb14f30
- Cannabis & Health Portal. (2025). CBD cancer: How cannabidiol contributes to treatment [GUIDE]. Retrieved May, 29, 2025, from https://www.cannabisesaude.com.br/cbd-cancer/
- Campos, M. R. *et al.* (2024). Smoking, mortality, access to diagnosis and treatment of lung cancer in Brazil. *Public Health Journal, 58*, 18.
- Carvalho, F. F. B., Malhão, L. C. M., & Moreira, L. G. M. (2025). Cancer as a public health challenge and the National Cancer Institute promoting physical activity in Brazil as a prevention and control action. *Brazilian Journal of Cancerology, 71*(2), e-005106.
- Cavalcante, S. (2021). Ozone in the treatment of cancer patients. Ozone Therapy Porto Alegre. Retrieved May, 28, 2025, from https://ozonioterapiaportoalegre.com/ozonio-no-tratamento-de-pacientes-com-cancer/
- Chai, Y. C. *et al.* (2023). Glutathione and glutaredoxin players in cellular redox homeostasis and signaling. *Antioxidants, 12*(8), 1553.
- Chen, D. (2025). Cancer genetics & epigenetics. Retrieved from May, 31, 2025, from https://thedishonscience.stanford.edu/articles/w31nkfkn3ollpkgvqhmd3b7fzntlst
- Clavo, B. *et al.* (2023). Effects of ozone treatment on health-related quality of life and toxicity induced by radiotherapy and chemotherapy in symptomatic cancer survivors. *International Journal of*

Environmental Research and Public Health, *20*(2), 1479.

- Conte, J. (2022). How does the use of medicinal cannabis for cancer treatment work? Retrieved May, 29, 2025, from https://drauziovarella.uol.com.br/cancer/como-funciona-o-uso-de-cannabis-medicinal-para-tratamento-do-cancer/
- Cordaro, M., Di Paola, R., & Fusco, R. (2024). Biochemical and physiological response during oxidative stress from invertebrates to vertebrates. In A. Das, S. Giri. (Eds.), Role of reactive oxygen species in carcinogenesis and polyphenols as an emerging therapeutic intervention. (pp. 1-29). London: Intechopen.
- Cotinguiba, G. G. *et al.* (2013). Method for assessing antioxidant defense: A literature review. *UNOPAR Scientific Biological Science Health, 15(*3), 231-237.
- CPAPS.com.br. (2025). Oxygen therapy in cancer treatment. Retrieved May, 25, 2025, from https://www.cpaps.com.br/blog/oxigenoterapia-tratamento-cancer/
- Death Skunk NGO. (2024). More Skunk your medical cannabis. Retrieved May, 30, 2025, from https://tratamentocomcbd.com.br/more-skunk-sua-plataforma-para-cannabis-medicinal/from
- Drope, J. *et al.* (2018). Who's still smoking? Disparities in adult cigarette smoking prevalence in the United States. *Cancer Journal for Clinicians, 68*(2),106-115.
- Gale, R. P. (2024). Molecular and cellular basis of tumor. Retrieved May, 25, 2025, from https://www.msdmanuals.com/pt/profissional/hematologia-e-oncologia/vis%C3%A3o-geral-sobre-c%C3%A2ncer/bases-moleculares-e-celulares-do-tumor
- Gouveia, S. S., & Lima, A. A. (2017). Insert the relationship between reactive species of oxygen and carcinogenic promotion. *Brazilian Journal of Surgery and Clinical Research, 20*(3), 174-179.
- Hanahan, D., & Weinberg, R. A. (2000). The hallmarks of cancer. *Cell, 100*, 57-70.
- Hong, Y. *et al.* (2024). Reactive oxygen species signaling and oxidative stress: Transcriptional regulation and evolution. *Antioxidants*, *13*(3), 312.
- Jelic, M. D. *et al.* (2021). Oxidative stress and its role in cancer. *Journal of Cancer Research and Therapeutics, 17*(1), 22-28.
- Keeton, A. B., Salter, E. A., & Piazza, G. A. (2017). The RAS-Effector interaction as a drug target. *Cancer Research, 77*(2), 221-226.
- Kim, W. (2019). Cellular stress responses in radiotherapy. *Cells, 8*(1105), 1-18.
- Kontorschikova, E., Kachalina, T., Yanchenko, O., & Kotelnikova, T. (2017). Ozonetherapy in the treatment of oncological patients. *Spanish Journal of Ozone Therapy, 17*(1), 39-50.
- Kozlov, A. V., Javadov, S., & Sommer, N. (2024). Cellular ROS and antioxidants: Physiological and pathological role. *Antioxidants, 13*(5), 602.
- Leonardi, G. C. (2018). Cutaneous melanomas: From pathogenesis to therapy (Review). *International Journal Oncolology, 2*(4),1071.
- Li, Y., Yao, J., Han, C., Yang, J., Chaudhry, M. T., & Wang, S. (2016). Quercetin, inflammation, and immunity. *Nutrients, 8*(3), 167.
- Liang, W. F. *et al.* (2021). Curcumin activates ROS signaling to promote pyroptosis in hepatocellular carcinoma HepG2 cells. *In Vivo, 35*(1), 249-257.
- Ligebel, J. A. *et al.* (2022). Exercise, diet, and weight management during cancer treatment: ASCO Guideline. *Journal Clinical Oncology, 240*(22), 2491-2507.
- Liou, G. Y., & Storz, P. (2010). Reactive oxygen species in cancer. *Free Radicals Response, 44*(5), 1-109.
- Lissa, F. Cancer Treatment. (2025). Technological advances in oncology: A new era in cancer treatment. Retrieved May, 29, 2025, from https://tratamentodocancer.com.br/avancos-tecnologicos-na-oncologia-uma-nova-era-no-tratamento-do-cancer/
- Majumder, D. *et al.* (2021). Understanding the complicated relationship between antioxidants and carcinogenesis. *Journal of Biochemical and Molecular Toxicology, 35*(2), e22643.
- Malta, D. C. *et al.* (2017). Evolution of smoking indicators according to telephone surveys, 2006-2014. *Public Health Notebooks, 33*, e00134915.
- Masters, N., Tutt, C., & Yaseen, N. (2022). Waterpipe tobacco smoking and cigarette equivalence. *British Journal of General Practice, 62*(596), 127.
- Masenga, S. K. *et al.* (2023). Mechanisms of oxidative stress in metabolic syndrome. *International Journal of Molecular Science*, 24, 7898.
- Massi, P. *et al*. (2013). Cannabidiol as a potential anticancer drug. *British Journal of Clinical Pharmacology, 75*(2), 303-312.
- Mayo Foundation for Medical Education and Research (MFMER). (2025). Cancer. Retrieved May, 25, 2025, from https://www.mayoclinic.org/diseases-conditions/cancer/symptoms-causes/syc-20370588
- Medicine Consultation. (2025). New cancer therapies: advances, FDA approvals, and hope for the future. Retrieved May, 30, 2025, from https://medicinaconsulta.com.br/novas-terapias-cancer/
- Medicina.in. (2024). CBD and effects on the lives of people with cancer. Retrieved May, 29, 2025, from https://medicina.in/conteudo/canabidiol/cbd-e-efeitos-na-vida-de-quem-tem-cancer/
- Ministry of Health (BR). (2021). Secretariat of Primary Health Care. Department of Health

Promotion. physical activity guide for the Brazilian population. Brasília: Ministry of Health.

- Mitrus, I. *et al.* (2012). Evolving models of tumor origin and progression. *Tumour Biology, 33*, 911-917.
- Mohammadzadeh, Z. *et al.* (2017). Systematic review of Hospital-Based Cancer Registries (HBCRs): Necessary tool to improve quality of care in cancer patients. *Asian Pacific Journal of Cancer Prevention, 18*(8), 2027-2033.
- More Skunk NGO. (2024). Cannabidiol treatment for cancer. Retrieved May, 29, 2025, from https://tratamentocomcbd.com.br/tratamento-com-canabidiol-para-cancer/
- Movahed, A., Nabavi, S. F., Sureda, A., Nabavi, S. M., & Echeverría, J. (2021). Protective effects of resveratrol against neurodegenerative diseases: role of the antioxidant activity. *Food and Chemical Toxicology, 154*, 112297.
- Murugesan, N., & Prabha, P. D. (2023). Antioxidant activity of synergistic quercetin and resveratrol. *Journal of Molecular Chemistry, 23*(581), 1-5.
- Nunes, B. (2024). Cancer: check out the treatments that have advanced the most in 2024. Retrieved May, 29, 2025, from https://www.metropoles.com/saude/avancos-nos-tratamentos-do-cancer-em-2024
- Nutritotal Pro. (2022). What is the relationship between antioxidants and cancer? Retrieved May, 26, 2025, from https://nutritotal.com.br/pro/qual-a-relaa-a-o-entre-antioxidantes-e-ca-ncer/
- Oncoguia Portal (2025). Technological innovations and new treatment protocols reinforce the fight against cancer. Retrieved May, 29, 2025, from https://www.oncoguia.org.br/conteudo/inovacoes-tecnologicas-e-novo-protocolo-de-tratamento-reforcam-o-combate-ao-cancer/17534/7/
- Oxy. (2024). What is hyperbaric oxygen therapy? Retrieved May, 25, 2025, from https://oxycamaras.com.br/contato/
- Pan American Health Organization (PAHO) (2022). Cancer. Retrieved May, 24, 2025, from https://www.paho.org/en/topics/cancer
- Parsonnet, J. *et al.* (1994). *Helicobacter pylori* infection and gastric lymphoma. *New England Journal of Medicine, 330*(18), 1267-1271.
- Parvaresh, A. *et al.* (2016). Quercetin and ovarian cancer: An evaluation based on a systematic review. *Journal of Research in Medical Sciences 21*, 34.
- Philozon. (2025). Effects of ozone treatment on health-related quality of life and toxicity induced by radiotherapy and chemotherapy in symptomatic cancer patients. Retrieved May, 28, 2025, from https://philozon.com.br/efeitos-da-ozonioterapia-na-qualidade-de-vida-relacionada-a-saude-e-na-toxicidade-induzida-por-radioterapia-e-quimioterapia-em-pacientes-com-cancer-sintomaticos/
- Pina, M., & Ribeiro, G. (2024). Ozone therapy in the treatment of cancer. Retrieved May, 28, 2025, from https://dramarciapina.com.br/ozonioterapia-no-tratamento-do-cancer/
- Pisanti, S. *et al.* (2017). Cannabidiol: State of the art and new challenges for therapeutic applications. *Pharmacology & Therapeutics,175*,133-150.
- Pollard, M., & Wolter, W. (2000). Prevention of spontaneous prostate-related cancer in lobund Wistar rats by a soy protein isolate/isoflavon diet. *Prostate, 45*, 101-105.
- Portal Education (2025). Carcinogenesis process. Retrieved Jun, 04, 2025, from https://www.portaleducacao.com.br/?utm_source=blogportal&utm_medium=blog
- Potter, P. A., & Perry, A. G. (2017). Fundamentals of Nursing. Rio de Janeiro: Elsevier.
- Rabelo, A. C. S., Borghesi, J., & Noratto, G. D. (2021). The role of dietary polyphenols in osteosarcoma: A possible clue about the molecular mechanisms involved in a process that is just in its infancy. *Journal of Food Biochemistry, 46*(44), e14026.
- Reekumar, A. (2016). Ozone therapy in integrated cancer management [Abstract]. Proceedings of the 5Th WFOT Meeting; Mumbai, India. *Journal of Ozone Therapy, 2*(2), 1-1.
- Reitz, L. K. *et al.* (2021). Dietary antioxidant capacity promotes a protective effect against exacerbated oxidative stress in women undergoing adjuvant treatment for breast cancer in a prospective study. *Nutrients, 13*(12), 4324.
- Remigante, A. *et al.* (2024). Redox homeostasis and antioxidant strategies in the pathophysiology. *Antioxidants, 13*(3), 281.
- Ribatti, D. (2017). The concept of immune surveillance against tumors. The first theories. *Oncotarget, 8*(4), 7175-7180.
- Rodríguez, B. LCL MED. (2025). News in cancer treatments in 2025: Hope for patients. Retrieved May, 29, 2025, from https://www.metropoles.com/saude/avancos-nos-tratamentos-do-cancer-em-2024
- Sanche, C. (2013). Knowing and understanding the cancer cell: Physiopathology of cancer. *Clinical Medical Journal Las Condes, 24*(4), 553-562.
- Santos, M. O. *et al.* (2023). Cancer incidence estimates in Brazil, 2023-2025. *Brazilian Journal of Cancerology, 69*(1), e-213700.
- Sawada, Y. *et al.* (2023). Effects of high-intensity anaerobic exercise on the scavenging activity of various reactive oxygen species and free radicals in athletes. *Nutrients, 15*(1), 222.
- Seeds of Good Project. (2024). The role of reactive oxygen species in carcinogenesis and the therapeutic potential of polyphenols. Retrieved May, 26, 2025, from https://www.projetosementesdobem.com.br/post/o-papel-das-esp%C3%A9cies-reativas-de-

oxig%C3%AAnio-na-carcinog%C3%AAnese-e-o-potencial-terap%C3%AAutico-dos-polifen%C3%B3is
- Seltzer, E. S., Watters, A. K., MacKenzie, D., Jr., Granat, L. M., & Zhang, D. (2020). Cannabidiol (CBD) as a promising anti-cancer drug. *Cancers*, *12*(11), 3203.
- Śledziński, P., Nowak-Terpiłowska, A., & Zeyland, J. (2021). Cannabinoids in Medicine: Cancer, immunity, and microbial diseases. *International Journal of Molecular Sciences, 22*(1), 263.
- Snezhkina, A. V. *et al.* (2020). ROS generation and antioxidant defense systems in normal and malignant cells. *Oxidative Medicine and Cellular Longevity. 19,* 6175804.
- Swann, J. B., & Smyth, M. J. (2017). Immune surveillance of tumors. *Journal of Clinical Investigation, 117*(5), 1137-1146.
- Tsuchiyae, A. *et al.* (2022). Development of flavonoid probes and the binding mode of the target protein and quercetin derivatives. *Bioorganic & Medicinal Chemistry, 68,* 116854.
- UFG Journal. (2021). Researchers synthesize nanoparticles that can treat cancer. Retrieved May, 29, 2025, from https://jornal.ufg.br/n/142057-pesquisadores-sintetizam-nanoparticula-que-pode-tratar-cancer
- UFG Post. (2021). Earwax in the fight against cancer: technique developed by UFG researchers revolutionizes early diagnosis. Retrieved May, 29, 2025, from https://pubs.acs.org/doi/abs/10.1021/acsanm.1c00027
- UOL. (2025). Education World. Cancer. Retrieved May, 22, 2025, from rhttps://mundoeducacao.uol.com.br/doencas/cancer.htm
- Vinícius-Araújo, M. *et al.* (2021). ZnxMn1–XFe2O4@SiO2:zNd3+ core–shell nanoparticles for low-field magnetic hyperthermia and enhanced photothermal therapy with the potential for nanothermometry. *ACS Applied Nano Materials, 4*(2), 2190–2210.
- Wang C. *et al.* (2019). Curcumin exerts cytotoxicity dependent on reactive oxygen species accumulation in non-small-cell lung cancer cells. *Future Oncology, 15*(11), 1243-1253.
- White, M. K., Pagano, J. S., & Khalili, K. (2014). Viruses and human cancers: a long road of discovery of molecular paradigms. *Clinical Microbiology Reviews*, *27*(3), 463-481.
- World Health Organization (WHO). (2025). Cancer. Retrieved from May, 23, 2025, from https://www.who.int/es/health-topics/cancer#tab=tab_1
- Xu, Y. *et al.* (2014). Free radical derivatives formed from cyclooxygenase-catalyzed dihomo-γ-linolenic acid peroxidation can attenuate colon cancer cell growth and enhance 5-fluorouracil's cytotoxicity. *Redox Biology, 2*, 610–618.
- Yadav, P. (2023). Cancer and normal cells: Difference and comparison. Retrieved May, 30, 2025, from https://askanydifference.com/difference-between-cancer-cells-and-normal-cells-with-table/
- Yallapu, M. M. *et al*. (2012). Curcumin-loaded magnetic nanoparticles for breast cancer therapeutics and imaging applications. *International Journal of Nanomedicine, 7*, 17611779.
- Yang, L., Courneya, K. S., & Friedenreich, C. M. (2024). The physical activity and cancer control (PACC) framework: update on the evidence, guidelines, and future research priorities. *British Journal of Cancer, 131*(6), 957-969.
- Yıldırım, F., Ocal, S., Ersoy, E. O., Rollas, K., & Aydoğan, B. (2017). High flow nasal oxygen therapy: From physiology to clinic. *Eurasian Journal of Pulmonology, 19*, 54-64.
- Yuan, C. *et al.* (2023). Curcumin induces ferroptosis and apoptosis in osteosarcoma cells by regulating Nrf2/GPX4 signaling pathway. *Experimental Biology and Medicine, 248*(23), 2183-2197.
- Zuardi, A. W. (2008). Cannabidiol: from an inactive cannabinoid to a drug with a wide spectrum of action. *Brazilian Journal of Psychiatry, 30*(3), 271-280.