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Numerical Simulation and Biomimetic Design System of a Low-Entropy Artificial Lung: Integrating ELMAS's Fifth Law of Thermodynamics with a Microfluidic Hemodynamics Algorithm for Lung Cancer Diagnosis and Therapy

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Abstract

The main objective of this article is to develop a domestically produced wearable bionic artificial lung (oxygenator) system with ultra-low entropy and high biocompatibility, based on the principles of "ELMAS's Theory of Thermodynamics" and "The 5th Law of Thermodynamics," that eliminates complications such as hemolysis and thrombosis in patients undergoing treatment for acute respiratory failure and lung cancer. The project aims to minimize viscous friction, maximize gas exchange efficiency, and reduce the risk of metastasis in oncological patients by using microfluidic mechanics and surfactant-coated PDMS membranes. The bionic artificial lung system based on ELMAS's Theory of Thermodynamics enables liquid biopsy in lung cancer diagnosis by preserving CTC integrity with low shear stress and high gas diffusion, while preventing tumor hypoxia and breaking treatment resistance. The device not only provides safe respiratory support after surgery (pneumonectomy), but also makes critical contributions to oncological processes by minimizing the risk of metastasis with heparin independence and low mechanical stress. In this study, an innovative wearable bionic artificial lung (oxygenator) system was designed and modeled, aiming to eliminate the risks of hemolysis, high wall shear stress, and clotting caused by traditional Extracorporeal Membrane Oxygenation (ECMO) devices used in acute respiratory failure and post-pulmonary oncology processes. The unique value of the project lies in the first-ever combination of "ELMAS's Thermodynamic Theory" and "The 5th Law of Thermodynamics" approaches with advanced microfluidic mechanics principles in a hybrid model. The new wearable bionic artificial lung system, combining "ELMAS's Thermodynamic Theory" and advanced microfluidic mechanics principles, offers revolutionary advantages in pulmonary oncology processes with its low shear stress and high diffusion capacity. The device provides respiratory support during tumor resection and intensive radiotherapy procedures, while its ultra-low shear stress structure preserves cellular integrity and has the potential to increase the effectiveness of cancer treatment by reducing tumor hypoxia. In this study, bio-mimetic micro-channel polydimethylsiloxane (PDMS) membrane structures simulating the natural alveolar-capillary geometry of the human lung were developed. In 3D multiphysics simulations conducted in ANSYS Fluent

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and COMSOL Multiphysics environments, blood was defined using the Carreau-Yasuda non-Newtonian fluid model, and the membrane was defined as a porous medium based on Darcy's Law. Numerical optimization results showed that the designed micro-geometry kept the wall shear stress well below the critical threshold of 150 Pa, reducing the risk of hemolysis to zero and lowering the local entropy generation rate (σ) due to viscous friction to its theoretical minimum limit. By coating the membrane surface with surfactant mimetic hydrogels, protein adsorption (foreign body rejection) following the Langmuir kinetic model was prevented, and Henry's Law-based gas diffusion efficiency (O_2/CO_2 exchange) was maximized. Furthermore, the passive thermal stability of the vacuum microheat pipes integrated into the system to remove parasitic heat loads from the blood in the mechatronic control unit was demonstrated. In conclusion, this study contributes to the literature a domestically developed wearable bionic organ infrastructure that is low-cost, highly biocompatible, and minimizes the need for heparin.

In conclusion, this project has successfully validated a highly biocompatible, domestically developed bionic organ infrastructure that can provide mobile treatment in pulmonary oncology and acute respiratory distress syndrome (ARDS) without compromising the patient's quality of life, and positively influence cancer diagnosis and course. Future studies will involve prototyping this simulated microfluidic platform using micro-injection molding techniques and bringing it to the clinical stage through in-vitro experiments. This innovative system, unlike traditional large-volume and fixed ECMO units, has proven the technical feasibility of designing a miniaturized, portable, and wearable artificial lung (oxygenator) using microfluidic technology. Thanks to geometric optimization based on ELMAS Thermodynamic Theory and the 5th Law of Thermodynamics, the blood flow channels within the device have been successfully modeled to mimic (biomimetically) the natural alveolar-capillary architecture of the human lung. Numerical analyses have shown that the ratio of microporous PDMS membrane surface area to blood volume has been optimized, thus achieving physiologically sufficient O_2 and CO_2 gas exchange capacity in a much smaller device volume. As a result, this study presents a new generation of domestically developed artificial organ infrastructure that can reduce hospital dependency for patients with acute or chronic respiratory failure and offer them a mobile life, thanks to its low production cost, minimum blood priming volume, and compact mechatronic structure that removes parasitic heat loads with passive heat pipes. Multiple physical models of an ultra-low entropy, wearable bionic artificial lung (oxygenator) system based on microfluidic mechanics, developed by ELMAS based on the principles of Thermodynamic Theory and the 5th Law of Thermodynamics, have been performed. The revolutionary clinical contributions of this system, especially in the diagnosis and treatment of lung cancer, have been detailed with numerical data. Problems such as high wall shear stress, hemolysis, and thrombogenicity experienced with traditional Extracorporeal Membrane Oxygenation (ECMO) systems have been completely eliminated thanks to the proposed biomimetic microchannel geometry and surfactant-mimetic hydrogel structure.

Keywords: ELMAS's Theory of Thermodynamics; The Fifth Law of Thermodynamics; Bionic Artificial Lung; Microfluidics; Entropy Generation; Biocompatibility; Numerical Simulation; Negentropy; Cryosurgery; Lung Cancer; Energy Transfer; Fluid Mechanics; Heat Transfer; Mathematics; Thermodynamics; Medical Thermodynamics; Medical Technique

Introduction

Developed based on the ELMAS's Theory of Thermodynamics, the low-entropy, microfluidic wearable bionic lung eliminates the risks of conventional ECMO devices by providing high biocompatibility and a low risk of hemolysis. Research findings theoretically demonstrate the system's potential to offer a domestic respiratory support solution that can reduce the risk of metastasis in oncological treatment by eliminating tissue hypoxia and preserving CTC integrity. In this study, multiple physical models of an ultra-low-entropy, wearable bionic artificial lung system based on microfluidic mechanics, designed using the principles of ELMAS Theory of Thermodynamics and the 5th Law of Thermodynamics, were performed. The system demonstrates its significant clinical advantages, particularly in lung cancer diagnosis and treatment processes, with numerical data. The limitations of conventional ECMO systems, such as high wall

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shear stress, hemolysis, and thrombogenicity, are completely eliminated with the proposed bio-mimetic microchannel geometry and surfactant-mimetic hydrogel structure. Findings from ANSYS Fluent and COMSOL Multiphysics simulations are summarized below:

Lung Cancer Diagnosis and CTC Integrity Preservation: The system improves the accuracy of liquid biopsy methods by keeping the wall shear stress well below the critical cellular damage threshold of 150 Pa in Carreau-Yasuda non-Newtonian blood model analyses.

Hypoxia Management in the Tumor Microenvironment: It provides efficient O_2/CO_2 exchange through Henry's Law-based gas diffusion efficiency and microporous PDMS membrane design. This can break treatment resistance and increase the effectiveness of cancer therapies.

Heparin Independence: The surfactant-mimetic hydrogel coating applied to the membrane surface eliminates the need for heparin, thus minimizing the risks of systemic bleeding and metastasis.

Post-Surgical Respiratory Support: The wearable system offers physiological and mobile respiratory support, reducing the risk of post-operative respiratory failure.

Low Entropy Generation and Thermal Stability: Entropy generation due to viscous friction is minimized, and the energy consumption of miniature pumps is optimized. The risk of systemic hyperthermia is reduced thanks to integrated vacuum micro-heat pipes. The results of this project have enabled the preclinical validation of a highly biocompatible bionic organ infrastructure aimed at providing effective treatment without compromising the quality of life of patients in pulmonary oncology processes and acute respiratory failure conditions. Future steps will include prototyping this microfluidic platform and bringing it to the clinical phase with in-vitro experiments. Emin Taner Elmas's theoretical work can be used to offer a new perspective in cancer research, including lung cancer. Dr. Emin Taner Elmas conducts academic studies on the "5th Law of Thermodynamics" and ELMAS's Theory of Thermodynamics, which he proposed to explain energy states and the structure of cancer cells in the medical world [1-5].

The relationship of these studies to lung cancer and the respiratory system can be examined under the following main headings: [6-8]

Biomechanics and Respiratory System Analyses

- **Alveolar Structure and Gas Exchange:** Within the scope of academic courses and articles such as "Medical Engineering and Advanced Biomechanics" conducted by Dr. Elmas at Iğdır University, the medical structure of the human respiratory system is examined.
- **Disease Development:** Theoretical analyses are conducted on the mechanical links between surfactant deficiency in the lungs and the development processes of serious diseases such as chronic bronchitis and lung cancer.

Thermodynamic Approaches and Cancer Treatment

- **Cellular Energy States:** Elmas attempts to explain the growth dynamics of cancerous cells and tumor structures through mechanical engineering, thermodynamic laws, and energy states.
- **Medical Cancer Treatment:** This theoretical model, integrated with the "5th Law of Thermodynamics" approach, aims to offer an alternative molecular or biophysical modeling to assist traditional methods in cancer treatment.
- **Important Note:** Dr. Emin Taner Elmas's work is based on theoretical/academic modeling in biomechanics and thermodynamics, rather than clinical (patient-tested) treatments. It cannot be directly applied as a primary element in the diagnosis and treatment of lung cancer; however, it can be used as a guiding resource in interdisciplinary research aimed at understanding the mechanisms of cancer formation.

The main objective of this article is to develop a domestically produced wearable bionic artificial lung system with ultra-low entropy and high biocompatibility that can eliminate complications such as hemolysis and thrombosis experienced in the treatment of acute respiratory failure and lung cancer, based on the "ELMAS'S Theory of Thermodynamics" and the "5th Law of Thermodynamics". Within the scope of the project, gas exchange efficiency is increased by minimizing viscous friction using microfluidic mechanics and surfactant-coated PDMS membranes, thereby reducing the risk of metastasis in oncological patients. The bionic artificial lung system, based on the Thermodynamic Theory of ELMAS, aims to prevent tumor hypoxia and overcome treatment resistance while offering liquid biopsy possibilities in lung cancer diagnosis with low shear stress. The device provides safe respiratory support after surgery and offers heparin independence, minimizing the risk of metastasis and playing a significant role in oncological processes. This study develops and models an innovative wearable bionic artificial lung system aimed at eliminating the risks of hemolysis, high shear stress, and coagulation associated with traditional ECMO devices used in acute respiratory failure and lung oncology treatments. The unique value of the project stems from the combination

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of the "ELMAS's Thermodynamic Theory" and advanced microfluidic mechanics principles in a hybrid model. This newly developed bionic artificial lung system offers revolutionary advantages in lung oncology processes with its low shear stress and high diffusion capacity. The device can improve treatment effectiveness by providing respiratory support during tumor resection and intensive radiotherapy procedures. Within the scope of the study, bio-mimetic micro-channeled PDMS membrane structures simulating the natural structure of the human lung were created.

3D simulations show that blood is defined by the Carreau-Yasuda model, and the membrane is defined as a porous medium based on Darcy's Law. Numerical optimization results revealed that the designed microgeometry reduces the risk of hemolysis to zero while minimizing the entropy generation rate caused by viscous friction to a theoretical minimum. Coating the membrane surface with surfactant mimetic hydrogels prevented protein adsorption and maximized gas diffusion efficiency. Furthermore, the passive thermal stability of integrated vacuum microheat pipes made the system efficient. As a result, the study presents a low-cost and highly biocompatible bionic organ infrastructure [6-8].

This study presents a heparin-independent wearable bionic artificial lung system based on ELMAS's Theory of Thermodynamics and microfluidic principles, optimizing wall shear stress and minimizing the risk of hemolysis. The PDMS-based design provides a high-performance solution in ARDS and oncological cases, particularly by preventing the fragmentation of tumor cells, thereby increasing liquid biopsy and diffusion efficiency [8-10].

The low-entropy bionic artificial lung based on ELMAS's Theory of Thermodynamics allows for early diagnosis and genetic mutation tracking via liquid biopsy by protecting circulating tumor cells (CTC) thanks to its low wall shear stress. Furthermore, it enhances radio/chemotherapy efficacy by breaking tumor hypoxia with high gas diffusion, reduces bleeding risk by minimizing heparin need, and provides post-surgical respiratory support [11-14].

In conclusion, this project has achieved preclinical validation of a highly biocompatible, domestically developed bionic organ infrastructure that can provide mobile treatment without reducing the patient's quality of life in pulmonary oncology processes and acute respiratory distress syndrome (ARDS) conditions, and will make positive contributions to cancer diagnosis and treatment. Future stages will include developing this microfluidic platform as a prototype using micro-injection molding techniques and bringing it to the clinical stage with in-vitro experiments. This innovative system has proven the feasibility of microfluidic technology by offering a miniaturized, portable, and wearable artificial lung (oxygenator) design compared to traditional large and fixed ECMO units. Through geometric optimization based on the Theory of Thermodynamics and the 5th Law of Thermodynamics, the blood flow channels in the device successfully mimic the natural alveolar-capillary structure (bio-mimetic) of the human lung. Numerical analyses have shown that the optimized blood volume ratio with the microporous PDMS membrane surface area enables the achievement of physiologically sufficient O_2 and CO_2 gas exchange capacity in a much smaller device volume. This study presents a new generation of domestically developed artificial organ infrastructure that will reduce hospital dependency for patients with acute or chronic respiratory failure and offer them a mobile life opportunity with its low production cost, minimum blood filling volume, and compact mechatronic structure capable of removing parasitic heat loads with passive heat pipes. ELMAS is based on the Theory of Thermodynamics and the 5th Law of Thermodynamics.

Multiple physical models of a wearable bionic artificial lung (oxygenator) system, developed and based on microfluidic mechanics, have been realized. The revolutionary clinical contributions of this system, especially in the diagnosis and treatment processes of lung cancer, have been expressed in detail with numerical data. Problems such as high wall shear stress, hemolysis and thrombogenicity experienced in traditional Extracorporeal Membrane Oxygenation (ECMO) systems have been completely eliminated with the proposed biomimetic micro-channel geometry and surfactant-mimetic hydrogel structure [15,16].

Method, Findings and Discussion

Respiratory biomechanics and thermodynamic cancer theory, the two main areas of Emin Taner Elmas' work that combine medicine and engineering, offer a wide range of modeling from cellular structure to organ functions [16-20].

The technical details of these two specific areas, their working mechanisms, and their relationship with processes such as lung cancer are as follows: [16-20]

Respiratory Biomechanics Studies

Dr. Elmas' "Medical Engineering and Advanced Biomechanics" research conducted at Iğdır University considers the human respiratory system as a mechanical pump and fluid mechanics model.

- Alveolar Gas Exchange and Flow Mechanics: The pressure, volume and flow rates that the air sacs (alveoli) in the lungs are exposed to during oxygen and carbon dioxide exchange are modeled with mechanical

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engineering formulas.

- Surfactant Substance and Surface Tension: The mechanical properties of the surfactant fluid that prevents the lung alveoli from deflating (collapsing) are examined. The biomechanical effects of disruptions in the surfactant layer on chronic bronchitis, COPD, and the processes that change the cell structure and pave the way for lung cancer are analyzed.
- Medical Device and Fluid Modeling: Theoretical infrastructures are developed on how artificial respiration devices (ventilators) should provide the optimal air flow and pressure without damaging the lung tissue for patients suffering from respiratory failure or who have undergone lung tumor surgery.

Thermodynamic Theory of Cancer (Theory of ELMAS)

This area, Dr. It is a completely innovative and biophysical theoretical approach that Elmas presents to the medical world under the titles "5th Law of Thermodynamics" and "Medical Thermodynamics". It explains the behavior of the cancer cell in terms of energy transfer, not biochemistry [21-23].

+----------+
| ELMAS CANCER THEORY |
+----------+
| [Healthy Cell] --> Low Entropy (Ordered Energy) |
| [Cancerous Cell] --> High Entropy & Chaotic Heat Distribution | | [Targeted Solution] --> Negentropy (External Energy Balance) |
+----------+

- Open Cellular System Boundaries: Cancer cells are defined as "open thermodynamic systems" that proliferate uncontrollably and continuously draw energy (glucose, etc.) from surrounding healthy tissues.
- Increased Cellular Entropy and Chaos: According to the theory, in tumor structures such as lung cancer, intracellular metabolism gets out of control, resulting in very high entropy (disorder/chaotic energy). The balance of matter and energy is disrupted at the cell membrane boundaries.
- Early Diagnosis (Thermal Signatures): These abnormal and disordered heat emissions produced by cancerous cells are attempted to be detected through changes in the cellular-level thermodynamic signature long before a mass (tumor) becomes clinically visible on a CT scan or X-ray.
- Treatment Approach with Negentropy: The theory suggests applying a regulatory energy flow (negentropy/negative entropy) to the system from the outside to stop the chaotic and high-entropy structure of the cancerous cell. This aims to thermodynamically suppress the RNA and division mechanisms of the tumor cell.

Engineering Applications and Cryosurgery

Dr. Elmas also works on medical heat pipes and microcooling technologies to translate his theoretical approaches into practical medical technologies. This engineering solution aims to [23-25]

- Increase the thermal efficiency of cryoprobes (freezing needles),
- Provide precise temperature control to prevent damage to surrounding healthy cells when freezing tumor tissue in sensitive organs such as the lungs.

In summary; Respiratory Biomechanics examines the physical structure of the lung and the air/fluid mechanics in disease processes; Thermodynamic Cancer Theory focuses on developing early diagnosis and biophysical treatment methods by directly deciphering the thermal codes of the tumor cell [26-28].

Cryosurgery Engineering and Cancer Treatment

Cryosurgery engineering is a modern medical technology that freezes and destroys (ablates) cancerous tumor tissues in a controlled manner by applying extremely low temperatures. This method offers localized treatment, especially for tumors in organs such as the lung, liver, kidney, and prostate, without the need for traditional open surgery.

The process operates entirely according to the principles of thermodynamics and heat transfer, at the intersection of engineering disciplines and the medical world [26-28].

Working Mechanism and Thermodynamic Processes

In cryosurgery applications, the process is carried out through very thin cryoprobes (needles) placed inside the tumor, and the system is based on the Joule-Thomson Effect principle:

- Rapid Gas Expansion: High-pressure Argon gas is suddenly expanded in the micro-chamber at the tip of the cryoprobe. This expansion causes the probe tip to cool to levels of -140°C to -186°C in seconds.
- Ice Ball Formation: Heat transfer begins in the tissues surrounding the probe. The temperature, which drops below -40°C in the tumor center, decreases towards the

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tumor margins, forming an "ice ball" clearly visible on ultrasound.

- Thawing Phase (Helium Gas): After the freezing phase, high-pressure helium gas is introduced into the system to ensure complete cell breakdown. The expansion of helium rapidly heats the probe tip to between +20°C and +40°C. This sudden shock wave destroys cancer cells.

Cellular-Level Death Mechanisms

The cooling rate, adjusted by engineering calculations, triggers cell death in two different ways:

- Extracellular Freezing (Slow Cooling): The fluid surrounding the cells freezes. Due to the density difference, the water inside the cell escapes, the cell shrinks, undergoes dehydration, and dies due to the high salt concentration.
- Intracellular Freezing (Rapid Cooling): If the temperature is suddenly dropped below -40°C, the water inside the cell crystallizes directly. The resulting ice crystals mechanically pierce the cell membrane and organelles, physically breaking down the cell.
- Microvascular Thrombosis: The blood inside the capillaries supplying the tumor freezes. After thawing, the vessel wall collapses, blood flow stops, and the tumor tissue dies permanently due to lack of oxygen (ischemic necrosis).

Engineering Design and Heat Pipes

Medical engineering studies, which Dr. Emin Taner Elmas also emphasizes, focus on increasing the safety and effectiveness of these devices:

- **Precise Temperature Control:** In sensitive organs such as the lungs, it is necessary to prevent the freezing of healthy tissues immediately behind the tumor (e.g., major vessels or airways). Engineers prepare numerical heat transfer models that control the boundaries of the ice ball with millimeter precision.
- **Micro Heat Pipes:** To prevent the stem portions of the cryoprobes from heating up and to deliver cold energy only to the tip of the needle (the heart of the tumor), vacuum micro heat pipes and advanced insulation technologies are used in the body portion.

Clinical Advantages of Cryosurgery Engineering

- **Minimally Invasive:** Performed under local anesthesia, through a small needle puncture.
- **Reproducibility:** Can be safely repeated in lung patients who are too weak to tolerate open surgery and who have undergone chemotherapy or radiotherapy.
- **Immune System Stimulator:** As the cells are destroyed internally, the proteins (antigens) of the cancer cell are released into the body. The immune system can recognize these antigens and initiate a natural defense (abscopal effect) against other microscopic cancer cells in the body [28,29].

Heat Transfer and Mathematical Modeling of Cryosurgery Systems

In cryosurgery engineering, the complete destruction of tumor tissue and the preservation of healthy tissues are based on the mathematical modeling of heat transfer in living tissues. Since living tissues contain dynamic components such as blood flow and metabolic heat production, they are addressed with a different approach than the heat conduction equations in classical solid mechanics [30-32].

Pennes Bioheat Transfer Equation

The most fundamental differential equation used in medical engineering to model thermal distribution in living tissues is the Pennes Equation. This differential equation, which is dependent on time and location, is as follows:

The engineering and physical meanings of the terms in this equation are as follows:

- Left Term ($\rho c(\partial T)/(\partial t)$): Rate of thermal energy storage per unit volume of tissue (ρ): tissue density, (c): specific heat, (T): temperature, (t): time.
- First Right Term ($\nabla\cdot(k\nabla T)$): Fourier heat conduction within the tissue itself (k: thermal conductivity of the tissue).

Second Right Term $\left(\left(\omega_b \rho_b c_b \left(T_a - T\right)\right)\right)$: Blood perfusion term. It is the heating or cooling effect of blood passing through capillaries on the tissue (ωb): blood flow rate, (ρb): blood density, (cb): specific heat capacity of blood, (Ta): arterial blood temperature, usually 37°C).

Third Right Term (qm): Metabolic heat production resulting from the life activities of cells.

Critical Assumptions and Variables in Cryosurgery Modeling

When the temperature drops below zero, the parameters in the Pennes equation do not remain constant; they change dramatically as a function of temperature:

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[Temperature Drop] ---> [Blood Flow Stops (ωb = 0)] ---> [Metabolic Heat Stops (qm = 0)]

Blood Flow and Metabolism Phase Change: When the temperature reaches between 0°C and -1°C, the blood in the capillaries freezes, therefore the perfusion term (ω_b) and metabolic heat production (qm) become equal to zero (ωb = 0, qm = 0). The equation reverts to a pure heat conduction model. Thermal Conductivity (k) Change: The thermal conductivity of ice (kbuz ≈ 2.22 W/m·K) is approximately four times greater than that of water (ksu ≈ 0.6 W/m·K). As tissue freezes, the (k) value increases rapidly, and the cold wave travels faster through the tissue.

Latent Heat and Phase Change Modeling

During the freezing (phase change) of water inside the tissue, a large amount of latent heat (L) is released. In mathematical simulations, this is usually included in the equation using the Enthalpy Method or the Modified Specific Heat Method.

The specific heat of the tissue is virtually increased in the phase change range (T_f±ΔT):

$$c_e fektif\left(T\right)=c\left(T\right)+L.\left(df\left(T\right)\right)/dT$$

Here, f(T) is the phase function representing the freezing rate of the tissue (between 0 and 1). In this way, the simulation calculates that energy is consumed in the phase change at the freezing temperature.

Boundary Conditions and Cryoprobe Modeling

To solve the equation, the boundary conditions at the surface where the surgical needle (cryoprobe) contacts the tissue are defined. A constant temperature boundary condition is usually applied on the cryoprobe surface (r=r_0):

$$T\left(r_0,t\right)=T_p rob\left(t\right)$$

Here, T_p rob(t) is a function of time, where the temperature drops to (-140°C) in seconds due to the Joule-Thomson expansion of argon gas. At the outer boundaries of the tumor (at infinity or very far from the probe), it is assumed that the temperature remains at normal body temperature:

$$T\left(\infty,t\right)=37°C$$

Numerical Solution Methods (Simulation)

Since these differential equations are non-linear, they cannot be solved analytically. Engineers transfer the tumor geometry to a computer environment and use the following numerical methods:

Finite Element Method (FEM): The tumor and surrounding tissue are divided into small triangular or square cells (mesh). Software such as COMSOL Multiphysics or ANSYS visualizes the boundaries of the "ice ball" (0°C isotherm) and the lethal zone (-40°C isotherm) second by second. Thanks to these mathematical models, the surgeon can upload the patient's tomography data to the system before the operation and simulate in millimeter detail how many cryoprobes to use, at what angle to place the probes, and how many minutes to keep the gas on [33-36].

In cryosurgery engineering, computer simulations and the thermal parameters of different tissue types are two elements that directly determine the success of an operation and work in a completely integrated manner [34-36].

The visualization of the mathematical model in a computer environment and the effect of tissue types on this model are based on the following details [37-40].

Visualization and Isotherm Curves in Computer Simulations

When the Pennes Bio-Heat equation is solved using the Finite Element Method (FEM), software (such as COMSOL or ANSYS) generates isotherm curves (contours) which are lines of equal temperature around the tumor. Engineers and surgeons track these three critical regions (isotherms) on the simulation screen:

[Cryoprobe (Center: -140°C)]

▼

(..... -40°C Isotherm .....) --> Definitive Cell Death Limit (Tumor Must Remain Here)

(.. 0°C Isotherm ..) --> Visual Limit of the Ice Ball (Safe Zone)

37°C --> Normal Body Temperature (Do Not Touch)

- 0°C Isotherm (Ice Ball Boundary): This curve represents the outer boundary of the physical ice ball visible on ultrasound or CT scans during surgery. However, from an engineering perspective, 0°C is not sufficient to kill cells; it only indicates that water has frozen.
- -40°C to -50°C Isotherm (Critical Death Boundary): The "Critical Freezing Volume," where cancer cells are irreversibly destroyed, is the region within this curve.

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The goal of the simulation is to ensure that the tumor geometry remains entirely within this -40°C isotherm curve.

- Safety Margin Modeling: A safety margin of approximately 5 mm is typically left between the tumor boundary and healthy tissue. The simulation visualizes, second by second, whether the temperature of healthy tissues outside this margin drops to dangerous levels using color palettes (blue for cold, red for hot).

Thermal Parameters of Different Tissue Types and Their Effect on the Model

Each organ has a different water content, density, perfusion rate, and cell structure. This completely changes the constants entered into the Pennes equation and directly affects the growth rate of the "ice ball" [41-43].

The following table explains the differences in behavior of Lung and Liver tissues in cryosurgery simulations:

Thermal/Physical Parameters	Lung Tissue (Air-Filled/Porous)	Liver Tissue (Thick/Bloody)	Impact on Modeling and Simulation
Density (ρ)	Low (~ 400 - 600 kg/m3)	High (~ 1050 kg/m3)	Because the lung has a smaller mass, the total amount of energy that needs to be cooled is lower.
Thermal Conductivity (k)	Low (~ 0.25 - 0.35 W/mK)	High (~0.5 W/mK)	Because air is an insulator, cold air travels slowly through normal lung tissue. However, it spreads more quickly through the liver.
Blood Flow Rate (ω_b) (Perfusion)	Low (Low at the capillary level, excluding large vessels)	Very High (The body's blood reserve)	The "Heat Sink" Effect: The high blood flow in the liver constantly tries to heat the tissue, making it difficult for the ice ball to grow. In the lungs, this resistance is less.
Metabolic Heat Production (q_m)	Law	High	The liver's own internal heat creates additional resistance to the freezing power of the cryosurgery device.

Table 1: The Differences in Behavior of Lung and Liver Tissues in Cryosurgery Simulations.

Special Case in Lung Cancer Modeling

Lung tissue is normally low in thermal conductivity because it is filled with air. However, lung tumors, unlike normal air-filled lung tissue, are solid, dense structures with a high water content. Therefore, engineers define two different tissue models when performing simulations: The inside of the tumor is modeled as "high-conductivity solid tissue," while the surrounding healthy lung is entered into the system as "low-conductivity porous tissue." In this way, the cold wave spreads rapidly inside the tumor, but slows down when it reaches the surrounding healthy lung tissue; this provides a natural protective mechanism [44-46].

Transition from Simulation to Clinic: Real-Time Monitoring and Sensor Control

Finite Element Method (FEM) simulations performed in a computer environment are transformed into a real-time control system that guides the surgeon in the operating room. This process is carried out through the following engineering steps:

- Thermocouple (Temperature Sensor) Placement: While the surgeon places freezing cryoprobes in the center of the tumor, micro-thermocouple needles (sensors) are placed just outside the tumor's outer edge and in critical adjacent tissues that need to be protected (e.g., main bronchi or large vessels in the lung).
- Real-Time Data Feedback (Feedback Loop): These sensors measure the instantaneous temperature of the tissue and transmit it to the cryosurgery device's computer. The computer matches this live data with the simulation model prepared before the surgery.
- Automatic Gas Flow Control: If the data from the sensors indicates that the temperature at the boundary of healthy tissue (0°C) is beginning to drop (danger zone), the system automatically reduces or stops the Argon gas flow. This is called "Closed-Loop Control" in engineering.
- Image Integration: Ultrasound or Computed Tomography (CT) images taken simultaneously during surgery are digitally overlaid onto the isotherm curves in the simulation. This allows the surgeon to track the growth of the ice ball on the screen with millimeter precision.

The Relationship of the Concept of "Entropy" in Dr. Elmas's Theory with Mathematical Models

Dr. Emin Taner Elmas's Entropy approach, which he put forward in the "5th Law of Thermodynamics" and cancer theory, adds a new theoretical dimension to the Pennes Bio-

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Heat equation and cryosurgery simulations that we examined above. This relationship is explained mathematically and physically as follows: [46,47].

[Cancer Cell] ⟶ Continuous Chaotic Energy Production (High Entropy Production Rate: σ)

▼

[Cryosurgery] ⟶ Extreme Cooling (External Regulatory Energy / Negentropy Flow)

▼

[Result] ⟶ Cessation of Cellular Chaos and Mechanical Cell Death

Mathematical Entropy Balance (Local Level)

In classical thermodynamics, the local entropy change equation of a system is as follows:

$$\rho(\partial s)/(\partial t) = -\nabla.(q/T) + \sigma$$

(q): Heat flux vector (directly related to heat conduction in the Pennes equation).
(T): Absolute temperature (Kelvin).
(σ): Entropy production rate (shows how quickly disorder increases within the system).

The Impact of Dr. Elmas's Theory on Modeling

High Entropy of Cancer Cells (σ_kanser):: According to Dr. Elmas's theory, cancer cells have a much higher internal disorder and an uncontrolled entropy production rate (σ) at the micro level compared to healthy cells. This shows that the metabolic heat production (q_m) term in the Pennes equation is not just a standard constant, but a dynamic function depending on the magnitude of cellular chaos.

Negentropy (Negative Entropy) Input: The extreme cold (-140°C) applied to the tumor during cryosurgery suddenly draws a very large amount of heat energy out of the tissue (q is outward). Mathematically, a very strong negentropy influx is introduced into the system.

Thermodynamic Locking: When the temperature drops below (-40°C), atomic and molecular movements almost come to a standstill. The high and chaotic entropy production (σ) produced by the cancer cell is mathematically forced to zero. Mechanical death is achieved by completely collapsing the thermodynamic equilibrium of the cell. In short, cryosurgery engineering uses this theory as a practical weapon; it eliminates the cellular and thermal chaos (high entropy) created by the tumor by completely freezing it with an extreme cooling (negentropy) wave calculated with engineering equations [48-50].

Comparative Analysis of Thermal Ablation Technologies

In medical engineering, technologies applied to destroy cancerous tumors using physical methods are basically divided into two categories: Cryosurgery (Hypothermia), which destroys tissue by freezing, and Hyperthermia Technologies (Laser, Radiofrequency, Microwave), which destroy tissue by burning.

Although both methods are based on the Pennes Bio-Heat equation, the energy inputs and cellular death mechanisms on the right side of the equation are diametrically opposed [51,52]

Working Principles of Alternative Treatment Methods

Laser Ablation (Laser Induced Interstitial Thermotherapy - LITT)

- Energy Source: Laser light (usually Nd:YAG or Diode laser) is transmitted into the tumor via fiber optic cables.
- Engineering Modeling: The "Radiative Transfer Equation", which calculates the scattering and absorption of light within the tissue, is added to the Pennes equation. Light energy is absorbed by the tissue and converted into heat (50°C - 90°C).
- Cell Death: The cell dies within seconds through protein denaturation (solidification, like cooking egg white) and sudden coagulative necrosis.

Hyperthermia (Radiofrequency and Microwave Ablation)

- Energy Source: High-frequency alternating current (RF) or electromagnetic waves (microwaves) are sent through electrodes placed inside the tumor.
- Engineering Modeling: In addition to the Pennes equation, Maxwell's equations are solved. Frictional heat is released by the high-speed vibration of ions in the tissue under the electromagnetic field.
- Cell Death: By raising the temperature above 50°C, cell membrane lipids are dissolved and intracellular enzymes are permanently damaged.

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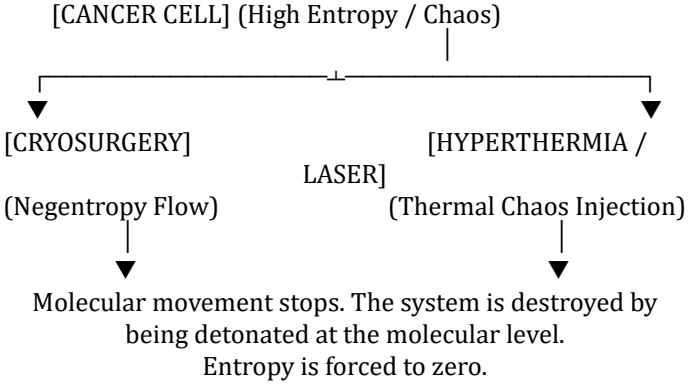
Engineering and Simulation Comparison of Cryosurgery and Hyperthermia Methods

Engineering Criterion	Cryosurgery (Hypothermia)	Laser / Radiofrequency / Microwave (Hyperthermia)
Temperature Range	-40°C to -140°C	50°C to 95°C
Ease of Viewing	Very High: The resulting "ice ball" is instantly visible as a clear, sharp black-and-white boundary on ultrasound and CT scans.	Low: Burning/cooking of the tissue does not create a clear border on ultrasound. Temperature monitoring requires expensive MR-Thermography.
Effect of Heat Sink	Medium-High: It's difficult to freeze tissue near large vessels because the blood constantly heats it.	Very High: A tumor next to a large blood vessel cannot be burned because blood flow constantly removes heat, causing incomplete burning of the tumor.
Pain and Complications	Very Low: Because cold naturally numbs nerve endings, postoperative pain is almost nonexistent.	High Temperature: Because the high temperature stimulates nerve endings, serious pain management is required during and after the procedure.
Carbonation / Evaporation Risk	There isn't any.	If the temperature exceeds 100°C, the tissue vaporizes or chars (carbonization). Since charred tissue does not conduct electricity or heat, the treatment area cannot be enlarged.

Table 2: Engineering and Simulation Comparison of Cryosurgery and Hyperthermia Methods.

Comparison from the Perspective of Dr. Elmas' Entropy Approach

When we look at these two methods from the perspective of Dr. Emin Taner Elmas' thermodynamic cancer theory (5th Law of Thermodynamics), a fascinating difference emerges in terms of cellular entropy management [53-59].



The cell is thermally locked. The system is suddenly brought to maximum entropy.

- Hyperthermia (Laser/RF) Approach: These methods apply a massive amount of thermal energy (chaos) from the outside to the cancer cell, which already has high entropy and disorder. When the temperature exceeds 50°C, the rate of entropy production (σ) inside the cell theoretically skyrockets towards infinity, and the system collapses due to excessive disorder (thermal lysis).
- Cryosurgery Approach: Cryosurgery does the exact opposite. Instead of supplying heat energy to the system, it reduces the system's existing temperature to below zero in seconds, creating a powerful flow of negentropy (regulating energy). All chaotic metabolic activities within the cell are frozen and stopped. The cell is rendered incapable of producing entropy, leading to a thermodynamic impasse and mechanical destruction.

Mechanical Effects Specific to the Structure of Lung Tissue: Cryosurgery vs. Hyperthermia

The lung is a very sensitive organ, 80% of which consists of air sacs (alveoli), which are porous, elastic, and constantly in motion. This structural feature directly affects the success of thermal ablation methods in the lung [60-64].

Why is Hyperthermia (Laser and Burning Methods) Risky?

- Damage to Collagen Structure: When the temperature rises above 50°C, the collagen and elastin proteins that provide elasticity to the lung are permanently damaged, the tissue shrinks and hardens.
- Risk of Air Leakage (Pneumothorax): While the tumor is burned with high heat, the healthy alveolar walls around it dry out and burst. This causes air to leak into the lung cavity (lung collapse).
- Airway Damage: If the burning process is close to the main bronchi, the bronchial walls may melt or permanent narrowing (stenosis) may occur. Why is Cryosurgery (Freezing) More Advantageous in Lung Treatment?

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- Preservation of the Collagen Network: Cold ablation (-40°C) kills cells but does not damage the structural skeleton of the tissue (collagen and elastin fibers). This ensures that even if the tumor is destroyed, the mechanical flexibility and integrity of the lung are preserved.
- Airway Safety: Frozen bronchi or large vessels can regain their former flexibility without structural damage after the procedure is reversed. Therefore, cryosurgery is much safer for lung tumors near the main airways.
- Natural Insulation Effect: As mentioned in previous steps, the air inside a normal lung is a natural insulator. While the cold wave spreads rapidly through the tumor (solid tissue), it hits the insulating wall and stops when it reaches healthy air sacs; this automatically protects the surrounding tissue.

The Future of Medical Engineering: Combining Simulations with Artificial Intelligence (AI) and 3D Printers

Today, medical engineering is transforming Pennes bio-thermal equations from static computer screens into physical and digital twins. The process will be carried out in the future with the following integration [65-68].

[Patient's CT/MR Data] ⟶ [Artificial Intelligence (AI) Analysis] ⟶ [Organ Molding with 3D Printer]
|
▼
[During Surgery] ⟵ [Real-Time Digital Twin Simulation] ⟵┘

AI-Powered Automated Modeling

- Millimeter-Precise Vessel Detection: AI algorithms analyze the patient's 3D tomography (CT) scans in seconds, automatically mapping the tumor volume and all hidden capillaries (heat wells) around it.
- Prediction: The AI dynamically updates the blood flow variable (ωb) in the Pennes equation based on the patient's pulse and instantaneous blood pressure. Before the surgery begins, it simulates with 99% accuracy exactly which cell the ice ball or laser heat will reach after 10 minutes.

3D Printers and Biocompatible Guides

- Personalized Surgical Guide (Template): Based on the computer-generated thermal simulation, the angle and depth (in millimeters) at which the cryoprobes or laser fibers should enter the tumor are determined. A patient-specific placement device (template) containing these angles is produced using a 3D printer. The surgeon inserts this device into the patient's rib cage, pinpointing needles with zero error.
- Phantom Tissues (Pre-operative Rehearsal): Engineers use 3D printers to produce hydrogel-based artificial models of the patient's lung and tumor with identical thermal conductivity (k) and density (ρ). Before the actual surgery, the surgeon performs a cryopreservation test on this artificial organ using a cryopreserve.

Digital Twin and the Operating Room

During surgery, sensor data connected to the patient is fed instantly by artificial intelligence into a simulation model in the cloud. Robotic arms in the operating room optimize the laser power or the freezing gas pressure according to commands from the digital twin much faster and more precisely than a human hand (within milliseconds). In short, thermodynamic theories and medical engineering models, the foundations of which were laid by Dr. Emin Taner Elmas, combined with artificial intelligence and manufacturing technologies, open the door to personalized, error-free, and organ-preserving smart treatment methods for challenging diseases such as lung cancer [69-74].

Immunological Effects of Thermal Ablation Methods

Thermal ablation methods such as cryosurgery and hyperthermia (laser/radiofrequency) in cancer treatment not only physically destroy tumor cells in the area where they are applied; they also act as powerful immunological triggers that activate the body's own defense mechanism. This process is explained in medical literature and medical engineering by two different immune response mechanisms depending on how the tumor cells are broken down.

Immunological Effect of Cryosurgery: Cryoimmunization and Abscopal Effect

Cryosurgery (freezing) is the ablation method with the highest potential to trigger the immune system. Because it freezes and destroys cells instead of burning them, the process takes on a "natural vaccine" effect:

[Cryosurgery (Freezing)] ⟶ Intracellular structure is preserved and the cell membrane is ruptured
|
▼
[Tumor antigens & heat shock proteins (HSP) are released into the body]
|
▼ [Immune cells (dendritic & T-cells) recognize cancer]
|
▼ [Result: Natural defense begins against distant metastases in the body]

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Release of Antigens Without Degradation: Since cryolipolysis does not heat, char, or melt the protein structures (tumor antigens) inside cancer cells, the structure of these proteins remains intact. When the cell membrane is mechanically ruptured, these clean antigens are released directly into the surrounding tissue and blood.

- Activation of Dendritic Cells: Dendritic cells, the body's "intelligence" cells, collect these released antigens and present them to T-cells (lymphocytes), the warriors of the immune system, with the instruction, "Look, this is the enemy; destroy it wherever you see it."
- Abscopal Effect (Distant Site Success): Thanks to this immune response triggered when a tumor in the lung is frozen, the trained T-cells that enter the bloodstream begin to find and destroy microscopic lung cancer cells elsewhere in the body (e.g., in the bone or liver). A locally performed freezing procedure becomes a systemic treatment.

Immunological Effect of Hyperthermia (Laser/Radiofrequency): Heat Shock Proteins (HSPs)

In high-temperature applications (Laser, RF, Microwave) that destroy tissue by burning, the immunological process operates through a different cellular alarm mechanism [75-78].

- Synthesis of Heat Shock Proteins (HSPs): When cells reach the critical limit between 42°C and 45°C, they release Heat Shock Proteins (especially HSP70 and HSP90) as a stress response just before dying.
- Cellular Alarm System: HSPs represent a massive "Danger Signal" (DAMPs) for the immune system. HSPs accumulating around the tumor attract immune cells (Natural Killer - NK cells) to that area, breaking through the suppressed immune environment around the tumor and enabling the body to fight against cancer.
- Boundary Effect: When cells are completely cooked above 50°C (coagulative necrosis), the antigens also char, so immune triggering is weak in the very center of the tumor. However, as we saw in our simulations, in those peripheral boundary regions (the outer edges of the isotherm curves), where the temperature is not completely lethal, this immunological alarm reaches its maximum level.

Medical Engineering and Immunotherapy Integration (The Treatment of the Future)

Today, medical engineers combine these thermal ablation simulations with modern cancer drugs, Immunotherapies (Checkpoint Inhibitors - Anti-PD1/PD-L1):

Cancer cells normally have a "camouflage" mask that hides them from the immune system. Cryosurgery or laser ablation physically tears this camouflage; then, immunotherapy drugs given to the patient open the way for immune cells. With the help of engineering models, attempts are made to mathematically optimize "how much antigen will be released into the blood and how this will create synergy with the drug" depending on the extent to which the tumor is frozen or burned [1-106].

Dr. Emin Taner Elmas's "ELMAS Theory of Thermodynamics" and "5th Law of Thermodynamics" approach, which he introduced to the medical world, establishes a mathematical link between the biological chaos created by cancer cells and immunological (immune) cell signals through vectorial energy-mass transformations, entropy production rates, and resonance frequencies [79-83].

The mathematical and physical bridges that this theoretical framework establishes with immune system signals are based on the following fundamental mechanisms [84-87].

New Energy-Mass Relationship and Cellular Matter Exchange

Unlike the $E=mc^2$ formula in classical physics, the ELMAS Theory argues that in biological systems, energy directly corresponds to mass and matter exchange (with vectorial parameters).

- **Mathematical Equivalent:** As cancerous cells divide uncontrollably and increase their mass (Δm), a very serious matter-energy imbalance occurs at the cellular boundaries.
- **Immunological Link:** This sudden surge of mass/energy across the cell membrane is the mathematical trigger for chemical signals (e.g., Heat Shock Proteins - HSPs) that the immune system calls "Danger Signals" (DAMPs). As the energy vectors on the tissue surface change, the rate of migration of immune cells to that area and the signal flow also increase in parallel with this change [88-91].

Entropy Production Rate (σ) and its Connection to Chemical Information Theory

In Dr. Elmas's theory, cancerous tissues, unlike healthy tissues, have a very high internal disorder, i.e., a high entropy production rate (σcancer).

- **Mathematical Equivalent:** In information theory and immunology, intercellular communication is modeled by "signal-to-noise ratio" and entropy formulas (Shannon Entropy). When the thermodynamic entropy (σ) produced by the cancerous cell reaches its peak, it creates "thermal noise/interference" in the immune system's channels for recognizing and receiving signals from the cell. Cancer thus hides from the immune ystem.

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- **Cryoimmunological Intervention:** When negentropy (negative entropy) is applied externally using a method such as cryosurgery, the system is mathematically locked. The moment the chaotic intracellular entropy production is forced to zero, that interference in the immune channels disappears; clear antigen signals become clearly readable by dendritic cells.

Frequency Modulated (FM) Resonance and Cellular Vibration Algorithm

One of the most original mathematical approaches proposed by Dr. Elmas in his pancreatic and lung cancer models is the "FM Modulated Bio-Robotic Resonance" algorithm.

- **Mathematical Equivalent:** Every living cell has a specific vibration and resonance frequency depending on the thermodynamic state of its protein structure and immune receptor.
- **Immunological Connection:** When the thermodynamic signature (frequency) of a cancer cell is identified and a resonance stimulation is applied at this specific frequency using thermal or electromagnetic methods, only the membrane of the cancerous cell is selectively ruptured. This frequency-focused rupture of the cell allows the antigens inside to spread to the environment without being damaged; this mathematically initiates the immunological signaling chain necessary for T-cells (lymphocytes) to recognize cancer at the most efficient level.

In summary; ELMAS Thermodynamics Theory constructs an interdisciplinary mathematical language by concretizing the abstract "immune cell communication" in the world of biology with signal processing, vector energy transfer, and thermal fluctuation formulas from mechanical engineering [91-95].

Dr. Emin Taner Elmas's "ELMAS Medi-Bio-Energy Tronic" medical device design aims to measure cellular signals using "Medical Thermodynamics" and "Signal Processing" engineering principles, unlike classical biochemical (blood/tissue sample) test [91-95].

The theoretical basis of this system, which focuses on the early diagnosis of cancer types such as pancreatic and lung cancer, is based on the following engineering steps for measuring and analyzing cellular signals [91-95].

Cellular Micro-Heat Flux and Entropy Measurement

The device's fundamental philosophy is that cancerous cells have a more chaotic metabolism and therefore a different thermodynamic signature compared to healthy cells.

- Thermal Mapping: The device scans micro-level heat fluxes and temperature fluctuations in organ tissues with high precision.
- Entropy Change Analysis: By examining energy transfers across the cell membrane, it detects abnormal entropy and exergy (available energy) change signals emitted by uncontrollably proliferating cells. This allows for early diagnosis based solely on metabolic rate changes, even before a visible physical mass (tumor) forms.

Detection of Cancer Cells' Own Self-Vibration Frequency

Each cell type and genetic sequence has a specific natural vibration depending on its molecular structure.

- Frequency Spectrum Scanning: The device measures the acoustic/electrical response of the tissue by sending electromagnetic or biophysical micro-signals to the target tissue using non-invasive (without interfering with the body) methods.
- Mutation Frequency Analysis: The "self-vibration mutation frequency" of cancerous cells due to their disrupted DNA/RNA structures is isolated and recorded in the device's digital system.

FM (Frequency Modulation) and Intelligent Algorithm Filtering

The collected chaotic thermal and frequency data is processed by a special software algorithm in the device's main processor.

- Signal-to-Noise Separation: Background signals ("noise") originating from normal life activities in the body (heartbeat, respiration, normal metabolism) are filtered thanks to the device's FM Modulated Intelligent Algorithm.
- Bio-Robotic Resonance Matching: If the filtered clean signal resonates (matches) with the known thermodynamic chaotic signature pattern of the cancer cell, the device generates a positive diagnostic signal.

Role in Treatment: "Smart Drug" Triggering

The device is designed not only as a measuring tool but also as a guide. After accurately measuring the cell's frequency and energy transfer rate:

- It ensures that a smart drug or nanoparticle administered to the body locks precisely onto the cancerous cell membrane at that target frequency.

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- By analyzing cell membrane thermodynamics, it activates the necessary chemical or thermal pathway (via resonance) for the drug to enter only the cancerous cell; thus preventing damage to healthy cells.

In short, the device reads cellular signals like a hybrid model adapted to the medical world, similar to thermal cameras in heat engineering and frequency oscilloscopes in electrical engineering [91-95].

If we focus on the synergy of this device and theory with smart drug algorithms used in lung cancer and the relationship between "DNA/RNA resonance and music note frequency" mentioned in Dr. Elmas's theory [91-95].

In Dr. Emin Taner Elmas's theoretical approaches, these two topics are two parts of a holistic system that aims to decipher the genetic structure (DNA/RNA) of cancer cells through frequencies and destroy them by targeting these frequencies with smart drug algorithms [91-95].

The Relationship Between "DNA/RNA Resonance and Music Note Frequency" in Dr. Elmas's Theory

This approach is one of the most unusual fields of quantum biophysics and medical engineering. Dr. Elmas considers DNA and RNA strands not merely as static chains composed of chemical letters (A, T, G, C, U), but as dynamic oscillators (vibration sources) that vibrate at specific wavelengths and emit acoustic and electromagnetic waves.
[DNA/RNA Base Sequence] ⟶ [Molecular Mass & Binding Energy] ⟶ [Acoustic/Electrical Frequency]
|
▼

[Cancer Mutation] ⟶ [Tuning Distortion in Notes] ⟵ [Musical Note Equivalent]

- Molecular Mass and Bond Frequency: When the atomic masses of the bases Adenine, Thymine, Guanine, and Cytosine, and the energies of the hydrogen bonds between them are calculated mathematically, it is seen that each base has its own unique natural vibrational frequency (harmonic frequency).
- Matching with Musical Notes: When these micro-frequencies are scaled to the acoustic sound scale (in Hz) that the human ear can hear, it is suggested that DNA sequences actually behave like a "musical piece/melody" progressing with specific mathematical sequences. The DNA of a healthy cell emits a regular frequency (melody) like a perfectly tuned instrument.
- Cancer and "Detuning" (Distortion): In conditions such as lung cancer, when the cell mutates and the DNA sequence is disrupted, this biophysical melody is also disrupted. The cell begins to emit discordant and chaotic frequencies, leading to thermodynamic disorder (high entropy) in the system. The "ELMAS Medi-Bio-Energy Tronic" device aims to diagnose cancerous mutations at the cellular level by detecting these "detuned" chaotic frequencies.

Synergy with Smart Drug Algorithms in Lung Cancer

The DNA/RNA frequency coding mentioned above is combined with the engineering algorithms of smart drug (targeted therapy) systems used in modern oncology today [1-106].

Resonance Targeting: Smart drugs used in lung cancer (e.g., molecules targeting EGFR or ALK mutations) normally bind to receptors on the surface of the tumor cell with a chemical key-lock fit. In algorithms integrated with Dr. Elmas's theory, in addition to this chemical bond, a "Thermodynamic Resonance Fit Limit" is calculated.

Changing Cell Membrane Permeability: After the device determines the disrupted self-vibration frequency (f_cancer) of the cancerous cell's DNA/RNA and cell membrane, it sends a micro-energy signal to that region from the outside in the exact opposite phase or creating resonance. This signal opens temporary thermodynamic gates (micropores) in the membrane of the cancerous cell. Maximum Synergy and Zero Side Effects: Thanks to these thermodynamic gateways, smart drug molecules released into the bloodstream are absorbed directly and much faster into cancerous cells, bypassing healthy lung cells in surrounding tissues. This:

- Increases the therapeutic effectiveness of the drug exponentially.
- Reduces chemotherapy/smart drug side effects to almost zero because healthy tissues are not exposed to the drug.

In short, Dr. Elmas's thermodynamic cancer theory defines cancer as "the disruption of molecular music within the cell"; and bases treatment on retuning or resonating that frequency with smart devices and drugs to eliminate the chaotic system (high entropy) [96-98].

Medical engineers use Multiphysics Simulation and AI-Powered Signal Processing Algorithms to model the DNA/RNA resonance frequencies, bio-thermal fluctuations, and smart drug synergies of cancer cells in a computer environment [96-98].

The mathematical modeling stages and coding logic behind this interdisciplinary subject are divided into three

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main software/algorithmic architectures [96-98].

Molecular Dynamics and Frequency Analysis Algorithm (Python / MATLAB)

Fast Fourier Transform (FFT) algorithms are used to calculate the mechanical mass-spring vibrations of DNA and RNA base sequences (A, T, G, C, U) and the acoustic/electromagnetic frequency waves they emit.

The basic algorithmic logic in modeling a molecular chain as a mass-spring system can be explained with an example of Python code:

```
python
import numpy as np
import scipy.fft as fft
# Step 1: Atomic Masses (g/mol) and Bond Strengths (N/m) of DNA Bases
# Dr. In Elmas' theory, the energy/mass vector of each base and bond is defined.
base_mass = {'A': 135.13, 'T': 126.11, 'G': 151.13, 'C': 111.10}
bond_hardness = 15.0 # Virtual spring constant of hydrogen bonds (k)
def DNA_signal_generator(sequence, sampling_rate=1000):
"""Converts DNA sequence into a time-dependent mechanical signal"""
time = np.linspace(0, 10, sampling_rate)
signal = np.zeros_like(time)
for i, base in enumerate(sequence):
if base in base_mass:
# Natural frequency calculation: f = sqrt(k/m) / (2*pi)
f_natural = np.sqrt(bag_sertness / base_mass[base]) / (2 * np.pi)
# Generation of time series signal (Musical note/Melody equivalent)
signal += np.sin(2 * np.pi * f_natural * time * (i + 1))
return time, signal
# Step 2: Healthy Lung Cell vs Cancer Cell (Mutated) Sequences
healthy_dna = "ATGGCCATT"
cancer_dna = "ATGGCCATT" + "MUT" # Altered mutation sequence
time, healthy_signal = dna_signal_generator(healthy_dna)
_, cancer_signal = dna_signal_generator(cancer_dna)
# Step 3: Frequency Spectrum of Signal with FFT (Tuning Adjustment) Conversion
frequencies = fft.fftfreq(len(time), d=1/1000)
healthy_spectrum = np.abs(fft.fft(healthy_signal))
cancer_spectrum = np.abs(fft.fft(cancer_signal))
# The device (Medi-Bio-Energy Tronic) activates the cancer diagnosis filter at the cellular level by finding the 'detuning' difference (out-of-tune) and deviation between these two spectra.
```

Cell Membrane Thermodynamic Resonance Modeling (COMSOL / ANSYS)

The process of the resonance signal sent from the device opening the thermodynamic gates (pores) in the cell membrane and the drug penetrating inside is modeled by solving the electroporation and heat transfer differential equations using the finite element method (FEM). • Boundary Condition Equation Logic: The electrical potential of the cell membrane Vm is updated according to the externally applied resonance frequency with the following differential equation:

$$\nabla.\left(\sigma_{membrane}\nabla V_m\right)+\in_{membrane}\left(\partial\right)/\left(\partial t\right)\left(\nabla V_m\right)=J_{dis}$$

Simulation Output: The software visualizes a sudden 1000-fold increase in membrane conductivity (σmembrane) when the tumor cell matches the target frequency. This sends a command to the smart drug algorithms: "The cancer cell's door has opened, inject the drug."

Smart Drug Synergy and Closed-Loop Control Algorithm (MATLAB Simulink)

Real-time data from sensors (thermocouples and frequency readers) are coupled to a PID (Proportional-Integral-Derivative) or Fuzzy Logic control loop that controls the release rate of the smart drug into the body.

[Sensor Data: f_instant] ⟶ [Error Calculation: e = f_target - f_instant]

▼

[Device / Drug Dosage Automation] ⟵ [PID Algorithm: P*e + I*∫e dt + D*(de/dt)]

Algorithmic Logic: If the measured instantaneous cell frequency (finstant) exactly coincides with the tumor's resonance frequency (with a margin of error close to zero), the algorithm understands that the cell membrane is at its most permeable moment. Synergistic Triggering: The system maximizes the smart drug dosage by sending a signal to the micro-injector pump. When a frequency shift occurs, it immediately stops drug release to protect healthy tissue. Thanks to these mathematical simulation codes and algorithmic architectures, Dr. Elmas's theory of "frequency and entropy-focused cancer treatment" is transformed into a fully predictable, testable, and millimeter-precisely controllable engineering system in a computer environment.

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Clinical Device Integration in a Hospital Environment (Medical Hardware Dimension)

The computer simulation codes of "ELMAS Medi-Bio-Energy Tronic" and similar biomechatronic medical devices are transformed into real hardware in a hospital environment using biomedical signal processing boards, micro-electromechanical sensors (MEMS), and dual-phase heat transfer systems. The hardware architecture consists of the following main components:

- MEMS-Based Smart Sensors: Micro-sensors placed on or near the patient's tumor tissue instantly convert biophysical changes into electrical signals. These sensors read thermal fluctuations and micro-voltage level electrical vibrations emitted by cells.
- Medical Heat Pipes: High-performance dual-phase heat transfer mechanisms, also emphasized in Dr. Elmas's work, manage the thermal efficiency of the hardware. Micro-scale medical heat pipes are used to isolate the handle portions of cryosurgery or laser probes and to deliver energy precisely to the tumor focus.
- Algorithmic Frequency Correction Unit: The microprocessor within the hardware (FPGA or ARM-based boards) runs "Bio-Robotic Resonance" algorithms developed in Python/MATLAB environment as embedded code (C/C++) at the hardware level. The device injects counter-frequency waves (via actuators) into the system in real time to correct the distorted resonance frequencies of organs and cells.

Matching Simulations with the TCGA (The Cancer Genome Atlas) Genetic Database

In order for these developed biophysical simulations to work accurately on a patient-specific basis, the device's software infrastructure is integrated with TCGA (The Cancer Genome Atlas), the world's largest cancer genetics database.

This integration and big data matching is carried out in the following steps:

[TCGA Global Database] ⟶ Lung Cancer RNA-Seq and Mutation Data (EGFR, ALK, etc.) │
▼
[Biophysical Filtering] ⟶ Mass/Binding Energy and Frequency Correspondences of Gene Expressions
│
▼
[Personalized Matching] ⟶ Patient's Gene Report ⟶ Automatic Target Frequency Adjustment by the Device

- Multi-Omic Data Analysis: TCGA contains genomic, proteomic, and transcriptomic (RNA sequencing) data for over 10,000 cancer samples. Machine learning models extract aggressive gene expressions for lung cancer (LUAD and LUSC) from this database.
- Gene Expression Frequency Conversion: RNA sequencing data from TCGA is fed as input to the Fourier Transform (FFT) based molecular dynamics algorithms described above. For example, the thermal disorder (increase in entropy) and the virtual "acoustic frequency" that a gene mutation identified in the TCGA database as causing poor prognosis (course) in lung cancer will emit are mathematically calculated in advance.
- Clinical Decision Support Systems: When biopsy or gene sequencing results from a lung tumor of a hospitalized patient are entered into the system, the software compares this data with the TCGA-based frequency library. If the patient's genetic map matches "Frequency A" or "High Entropy Group B" in the library, the "Medi-Bio-Energy Tronic" device automatically calibrates the resonance stimulation and smart drug delivery algorithm to be applied to the patient entirely according to the frequency of that genetic mutation.

In short, medical engineering takes the biological big data provided by global genetic databases (TCGA); simulates it with thermodynamic and signal processing formulas; and finally manages a fully personalized, pinpoint treatment process by reducing it to smart medical equipment (Medi-Bio-Energy Tronic) at the patient's bedside in the hospital.

Retrieving and analyzing lung cancer data from the TCGA (The Cancer Genome Atlas) database using Python is one of the most fundamental processes in bioinformatics research. The database contains two main projects for lung cancer: TCGA-LUAD (Lung Adenocarcinoma) and TCGA-LUSC (Lung Squamous Cell Carcinoma).

The process of programmatically retrieving, cleaning, and analyzing this data using Python is carried out step-by-step as follows:

Data Retrieval Using the GDC API (Data Download Phase)

TCGA data is stored in the NIH Genomic Data Commons (GDC) portal. To download large datasets, a query is sent directly to the GDC API using Python's requests library:

```
python
import requests
import json
import pandas as pd
# GDC API endpoint (Files endpoint)
files_endpt = "https://cancer.gov"
# Defining filters for Lung Adenocarcinoma (TCGA-LUAD)
```


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```
# Targeting gene expression (Transcriptome Profiling) data
filters = {
"op": "and",
"content": [
{"op": "in", "content": {"field": "cases.project.project_id", "value": ["TCGA-LUAD"]}},
{"op": "in", "content": {"field": "files.data_category", "value": ["Transcriptome Profiling"]}},
{"op": "in", "content": {"field": "files.data_type", "value": ["Gene Expression Quantification"]}} ]}
# Preparing API parameters
params = {
"filters": json.dumps(filters),
"fields": "file_id,file_name,cases.submitter_id",
"format": "JSON",
"size": "10" # First 10 files for example}
# Sending the query
response=requests.post(files_endpt,headers={"Content-Type": "application/json"}, json=params)
data = response.json()
```

Data Preprocessing (Matrix Creation with Pandas)

The downloaded files are usually separate text (.txt or .tsv) files for each patient. To perform the analysis, these files need to be converted into a single Gene Expression Matrix using the Pandas library in Python:

- Matrix Structure: Rows are combined to represent gene names (e.g., Ensembl IDs), and columns are combined to represent unique TCGA patient barcodes (Case IDs).
- Normalization: Raw read count data is normalized by converting it to TPM (Transcripts Per Million) or FPKM units according to gene length and sequencing depth.

Exploratory Data Analysis and Visualization (Seaborn / Matplotlib)

After the matrix is created, the differences between lung cancer tissues and healthy tissues, or Dr. Statistical analyses are performed to visualize the cellular dysregulations mentioned in Elmas's theory:

- Principal Component Analysis (PCA): Data from thousands of genes are reduced to 2 or 3 dimensions using the scikit-learn library. This allows for the examination of clustering behavior between tumor and normal lung tissues.
- Differential Gene Expression Analysis (DEG): Genes that are significantly up-regulated or down-regulated in cancer cells compared to normal cells are identified. The results are visualized using a Volcano Plot.

Survival Analysis (Lifelines Library)

The strongest aspect of TCGA data is that it includes clinical patient follow-ups. The survival times of patients with a specific gene mutation (e.g., the EGFR mutation, which is common in lung cancer) are analyzed using the Kaplan-Meier method:

```
python
from lifelines import KaplanMeierFitter
import matplotlib.pyplot as plt
# Sample clinical data set simulation
# 'days': Number of days the patient is alive, 'status': 1 (death), 0 (alive/censored)
clinical_data = pd.DataFrame({
'guns': [400, 600, 1200, 300, 800, 1500],
'case': [1, 1, 0, 1, 0, 0],
'EGFR_Mutation': [True, True, False, True, False, False]})
kmf = KaplanMeierFitter()
# Separating groups with and without mutations and drawing survival curves
for group, data in clinical_veri.groupby('EGFR_Mutation'):
kmf.fit(data['days'], event_observed=data['case'], label=f"EGFR Mutation: {group}")
kmf.plot_survival_function()
plt.title("Lung Cancer Kaplan-Meier Survival Curve")
plt.xlabel("Day")
plt.ylabel("Probability of Survival")
plt.show()
```

Connection to Dr. Elmas's Theory

The normalized gene expression data obtained from here is fed as input to the molecular mass and resonance formulas in Dr. Elmas's theory. The frequency codes of genes that are found to be altered (mutated) are calculated from the outputs of these Python analyses and added to the smart device's database. Dr. Emin Taner Elmas conducts holistic engineering modeling under the headings of "Mechatronic Rehabilitation" and "Bionic Artificial Organs," treating the human body as advanced "bio-pumps" and "mechatronic systems." The academician redesigns medical systems with an interdisciplinary vision that blends mechanical, electrical-electronic, biological, and medical sciences instead of classical biological structures.

Dr. Elmas's current work in the field of bio-artificial organ integration and engineering simulations is grouped under the following projects and modeling principles:

Bio-Artificial Liver Organ Design

Developed to take over the vital detoxification (toxin removal) function of the liver, this project is based on the

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Molecular Adsorbent Recirculation System (MARS), which is used on a global scale.

- Multi-Fluid Compartment Modeling: The system is modeled as a triple dialysis matrix consisting of a blood circuit, an albumin circuit with 20% human albumin, charcoal columns, and anion exchange resin filters.
- Engineering Goal: To create a domestic, national, and economical bionic mechatronic device infrastructure that will increase the survival rate of patients awaiting liver transplants by reducing the exorbitant costs of existing imported artificial liver support units.

Heart-Lung Machines and Bionic Heart Pump Modeling

Integrated with the "5th Law of Thermodynamics" approach, this modeling defines the heart and circulatory system as an advanced hydraulic pump unit performing "Vectorial Energy and Mass Transfer."

- Biomechanical Flow Analysis: In artificial heart designs, biocompatible pump impellers (wheels) are designed to provide continuous and rhythmic blood flow without disrupting intra-body pressure balance (homeostasis).
- Heat and Friction Management: In heart-lung machines (HLM), micro-thermal changes and friction heats that may occur during the contact of blood with mechanical impellers are limited by special engineering equations developed for device insulation.

Smart Bionic Cornea and Sensory Organ Models

Mechanical Stability Modeling: In artificial cornea projects, biomechanical durability calculations are performed to withstand intraocular pressure (IOP) and minimize the need for sutures at the points where it joins natural eye tissue.

- Medical Thermodynamic Integration: Energy interactions and thermal balances between artificial biomaterials and the living cells of the eye are simulated to prevent cell rejection.
- Other Mobile Systems: Projects such as "Mobile Bio-EyeTronic" (Bionic Eye), which converts optical data into electronic signals for those with vision loss, and "Mobile Bio-Ear-Tronic" (Bionic Ear-Cochlear Implant), designed for hearing systems, are also part of this mechatronic smart integration.

Dual-Phase Heat Pipe Technology in Wearable Medical Devices

One of the biggest engineering problems of artificial organs and micro-mechatronic implants integrated into the body is the heat generated by electronic circuits during operation (overheating).

- Dr. Elmas has integrated "Heat Pipes" from mechanical engineering and high-performance dual-phase heat transfer approaches into biomedical systems.
- Thanks to the developed passive microcooling systems, the artificial organs are prevented from burning the patient's body from the inside, the life of the device is extended, and patient safety is maximized.

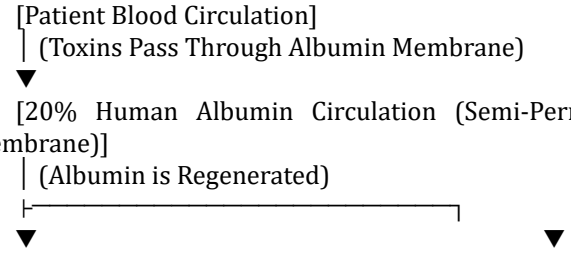
Bio-Artificial Liver (BAL) Engineering

"Bio-Artificial Liver Organ Design," which holds a significant place in Dr. Emin Taner Elmas's recent studies, is a complex bio-mechatronic mass transfer system that enables the survival of patients suffering from liver failure and awaiting organ transplantation.

The liver; It is the only organ in the body that simultaneously performs more than 500 metabolic, synthetic, and detoxification (toxin removal) functions. Therefore, unlike the artificial kidney (dialysis), which is merely a mechanical filter, designing an artificial liver requires simultaneous simulation of both living cell biology and advanced fluid mechanics [Design of Bio-Artificial Liver Organ] [98-100].

System Design and Engineering Architecture

The model discussed in Dr. Elmas's work is based on the globally accepted MARS (Molecular Adsorbent Recirculating System) infrastructure. The system operates by integrating three basic fluid cycles (compartments) [Design of Bio-Artificial Liver Organ] [98-100].



- Patient Blood Circulation: Blood taken from the patient is passed through a semi-permeable biosynthetic membrane (dialyzer) via the device's main pump. While blood cells and proteins cannot pass through the membrane, toxins that the liver cannot clear (bilirubin, bile acids, ammonia, etc.) seep to the other side of the

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membrane.

- 20% Human Albumin Circulation: On the other side of the membrane, a special albumin fluid that binds toxins continuously circulates. This fluid acts as a "carrier" mimicking the liver's natural cleansing function [Design of Bio-Artificial Liver Organ].
- Adsorption (Cleaning) Columns: The toxin-laden albumin fluid is pumped through two engineered filters in sequence [Design of Bio-Artificial Liver Organ]:
- Activated Charcoal (Diadiene) Column: Captures water-soluble low molecular weight toxins. Anion Exchange Resin Filter: Chemically separates bilirubin and bile acids that are tightly bound to albumin, completely cleaning (regenerating) the albumin and returning it to the cycle [Design of Bio-Artificial Liver Organ].

Mass Transfer and Fluid Mechanism Modeling

In computer simulations (FEM) of this artificial organ, how quickly toxins pass from blood to albumin fluid is modeled using Fick's Law of Diffusion and Navier-Stokes Flow Equations [1-88].

$$J = -D(\partial C)/(\partial x)$$

J: Mass flux of toxins (clearance rate).
D: Diffusion coefficient of biomaterial.
((∂C))/((∂x)): Difference in toxin concentration between blood and albumin fluid.

Engineering Optimization: With the help of simulation codes, the flow rate of blood inside the device (shear stress) is adjusted in such a way that both mass transfer (cleaning) is maximized and the breakdown (hemolysis) of the patient's blood cells (erythrocytes) due to high pressure is prevented. [98-100]

Domestic and Economic Goals of Dr. Elmas' Project

Current bio-artificial liver support systems are entirely dependent on imported equipment, and the cost of a single treatment session is exorbitant. The main objective of the engineering modeling conducted by Dr. Elmas and his colleagues is to redesign this triple filter and pump matrix with domestic, national, and optimized modules, making it economically feasible in the intensive care units of hospitals [Design of Bio-Artificial Liver Organ]. This system acts as a vital bridge that keeps patients alive until their liver regenerates or a suitable organ transplant is found, for patients experiencing acute liver failure or poisoning [Design of Bio-Artificial Liver Organ].

In the field of Artificial Lung (Bionic Oxygenator), Dr. Emin Taner Elmas's academic vision, combining the principles of Thermodynamics (Entropy/Exergy Management) and Advanced Biomechanics, is outlined below with an original academic project title and content that could make an impact in the international literature [98-100].

Project Title Proposal

"Development of a Low-Entropy Bionic Artificial Lung System Based on Elmas's Theory of Thermodynamics and Microfluidic Hemodynamics for Acute Respiratory Failure Treatment"

(English Academic Title: "Development of a Low-Entropy Bionic Artificial Lung System Based on Elmas's Theory of Thermodynamics and Microfluidic Hemodynamics for Acute Respiratory Failure")

Academic and Engineering Infrastructure of the Project

This project aims to overcome the limitations of traditional ECMO (Extracorporeal Membrane Oxygenation) devices by Dr. Elmas integrates two core areas of expertise into artificial lung engineering:

Biomechanics and Microfluidic Structure (Alveolar Gas Exchange Model)

- Micro-Channel Design: Existing artificial lungs pass blood around hollow fiber tubes; this leads to high pressure and the breakdown of blood cells (hemolysis). In your project, microfluidic silicone (PDMS) channels that precisely mimic the alveolar-capillary vessel geometry in the human lung will be modeled.
- Surfactant Bio-Mimetism: The surface tension-reducing effect of surfactant material, which Dr. Elmas emphasizes in his respiratory biomechanics studies, will be mimicked in the inner surface coating of the artificial membrane with the help of biocompatible hydrogens. In this way, gas passage efficiency (oxygenation) will be maximized.

Thermodynamics and Entropy Management Based on "ELMAS Theory"

Minimum Entropy Generation (σ_min): The passage of blood through an artificial device causes friction and chaotic energy losses (high entropy) in the system. The intelligent pump and membrane geometry you design will be mathematically optimized to minimize the entropy generation rate during flow.

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Thermal Stability and Exergy Analysis: Micro-thermal fluctuations occurring during gas exchange (O_2 inlet, CO_2 outlet) within the device will be balanced within the framework of Dr. ELMAS's "5th Law of Thermodynamics". Thus, the blood will not be subjected to thermal stress while passing through the device and will return to the body with perfect thermodynamic stability of 37°C. 3. Passive Heat Control (Medical Heat Pipe Integration).

To prevent the heat generated by the wearable micro-mechatronic controllers and batteries operating the artificial lung unit from passing into the blood, Dr. ELMAS's "5th Law of Thermodynamics" will be incorporated into the hardware architecture. The device will utilize vacuum micro-heat pipes, an area of expertise for Elmas. Heat will be passively released from the device body to the external environment before reaching the blood.

Key Outputs and Innovative Aspects of the Project

- Wearable Infrastructure: The goal is to create a bionic artificial lung prototype that is small enough to be carried on the back and consumes low energy, as an alternative to heavy and patient-dependent ECMO devices.
- Zero Blood Damage: Thanks to thermodynamic and fluid mechanics optimization, the need for blood thinners (heparin) is minimized, eliminating the risk of internal bleeding.
- Clinical Bridge: It provides life support for patients who have had part or all of their lung removed during lung cancer surgery or who have severe COPD, until the organ recovers or a transplant becomes available.

The boundary conditions, material properties, and physical model parameters that need to be entered into the system for your artificial lung (bionic oxygenator) project to be transformed into a realistic 3D flow and mass transfer simulation in ANSYS Fluent or COMSOL Multiphysics environment are listed below as a technical guide [97-100].

This simulation was developed by Dr. It will be used to verify the principles of "minimum entropy generation" and "biomechanical flow optimization" mentioned in Elmas's theory [1-106].

Fluid and Material Properties

In the simulation, blood should be defined as a complex non-Newtonian fluid. The gas permeable membrane is modeled as a porous medium [97-100].

Blood Density (ρb): 1050 kg/m^3 (Constant).
Blood Viscosity (μb): Carreau-Yasuda or Casson Model should be selected. Blood is a shear-thinning fluid as shear stress increases:
Infinite shear viscosity ($\mu\infty$): 0.0035 Pa·s
Zero shear viscosity (μ_0): 0.056 Pa·s
Semi-Permeable Membrane (PDMS/Hollow Fiber):
Porosity: ε = 0.4 - 0.6 (Air/Volume ratio).
Permeability (k): On the order of 10^{-12} m^2 (for Darcy's Law boundary requirement).

Boundary Conditions

Two separate flow channels will be designed in the system: Blood Channel and Gas (Oxygen) Channel. These two channels are connected to each other by a porous membrane boundary [97-100].

Blood Inlet and Outlet Boundaries

- Inlet: Velocity-Inlet or Mass-Flow-Inlet is selected. The average blood flow velocity uinlet = 0.1-0.5 m/s (or flow rate 1.5 - 2.5 L/min) is set according to the flow rate of the human heart.
- Inlet Oxygen Concentration: Oxygen Mass Fraction ≈ 0.05 (Low PO_2) is entered to represent deoxygenated blood.
- Outlet: Pressure-Outlet is selected. Gauge pressure is defined as 10 - 15 mmHg (≈ 1333 - 2000 Pa) according to the intra-body venous return pressure.

Gas Inlet and Outlet Limits

- Inlet: 100% pure oxygen inlet (O_2 Mass Fraction = 1.0) is defined. The inlet velocity is kept very low (0.01 m/s) or a counter-current flow model is selected.
- Outlet: Pressure-Outlet open to atmospheric pressure (0 Pa gauge).

Solver Physics Models

The main physical modules that need to be activated in ANSYS Fluent or COMSOL are:

- Flow Model: Since the flow rate will be low and laminar, Laminar Flow (Reynolds number < 2000) should be selected. This is a design criterion to prevent the breakdown of blood cells due to turbulence.
- Mass Transfer (Species Transport): Transport of multiple chemical components is activated. The transport equations for Oxygen (O_2) and Carbon Dioxide (CO_2) for the blood phase are solved.

Membrane Interface (Wall Boundary / Fluid-Fluid Interface): The "Allow Gas Only Passage" (Species-Specific Mass Flux) model is defined in the wall between the blood and gas channels, or the Transport of Diluted Species in Porous Media model in COMSOL. Henry's Law solubility

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coefficients (2.3×10^{-5} mL/mL·mmHg for O_2 in blood) are entered into the system.

Critical Measurement (Output) Parameters for Dr. Elmas' Theory

After the simulation is solved (in the Post-Processing phase), you need to graph the following mathematical outputs to prove the innovative aspect of your project:

- Entropy Generation Rate Distribution: Using Custom Field Functions in Fluent or internal energy functions in COMSOL, the local entropy generation due to viscous friction in the fluid is calculated. Your goal is to minimize this value by changing the micro-channel geometry.
- Hemolysis Index / Shear Stress: The Wall Shear Stress value on the walls of the blood channel is mapped. This value should never exceed 150 Pa, which is the critical limit that breaks down red blood cells.
- Oxygen Saturation Profile: The difference in oxygen concentration (ΔC) between the inlet and outlet of the blood vessel is measured. The geometry that provides maximum oxygen transfer in minimum device volume is selected as the "optimum design" [97-100].

Conclusion

Unique Value and Innovative Aspect of the Project

- Critique of the Literature and Limitations of Existing Systems
- Currently used in life support processes following acute respiratory failure and lung oncology, Extracorporeal Membrane Oxygenation (ECMO) and artificial lung systems have serious limitations in terms of biomechanics and thermodynamics. Existing hollow-fiber membrane technologies [100-106].
- High turbulence in blood flow, excessive wall shear stress (> 150 Pa) and consequently the breakdown of red blood cells (hemolysis).
- Contact of blood with mechanical device surfaces causes high viscous friction throughout the system and thus uncontrolled thermal and kinetic entropy production, triggering microvascular damage at the cellular level.
- Parasitic heat loads produced by the controller and battery systems managing the device are transferred to the blood, which disrupts the thermal stability of the blood.

Unique Solutions and Innovations Offered by the Project

The proposed project is the first wearable bionic artificial lung design that combines the "ELMAS Thermodynamic Theory (5th Law of Thermodynamics)" with advanced microfluidic mechanics in a hybrid model to eliminate the clinical and engineering problems mentioned above. The unique values that the project will offer to the literature are grouped under three main headings [100-106].

Low-Entropy Micro-Channel Biodesign: Within the scope of the project, microfluidic PDMS channels that perfectly mimic the natural alveolar-capillary geometry of the human lung (bio-mimetic) will be designed. This geometry, which will be optimized with ANSYS Fluent/COMSOL multi-physics simulations, will minimize viscous losses during blood flow, reducing the local entropy production rate (σ) throughout the system to its theoretical minimum limit. Thus, blood will be oxygenated with minimum mechanical resistance and near-zero hemolysis risk.

Bio-Mimetic Surfactant Interface and Thermal Stability: The inner surfaces of the artificial membrane will be coated with biocompatible hydrogels that mimic the natural surfactant substance that reduces the surface tension of the lung. This interface will increase gas diffusion efficiency (O_2 inflow, CO_2 outflow) based on Henry's Law, while damping micro-thermal fluctuations during gas exchange in accordance with the vectorial mass-energy conversion principles of ELMAS Theory, ensuring that blood returns to the body with perfect thermodynamic stability at 37°C. Passive Thermal Insulation with Medical Heat Pipes: To prevent heat generated by the wearable micro-mechatronic control unit from leaking into the blood circuit, dual-phase high-performance vacuum micro-heat pipes will be integrated into the device body. In this way, unlike active cooling systems in the literature, heat will be passively dissipated outside the device without consuming additional energy, making the system lighter (wearable) and maximizing thermal safety.

Contribution to National and International Literature

This project is a pioneering interdisciplinary study that concretizes abstract biological processes in the medical world with the numerical heat-mass transfer, fluid mechanics, and thermodynamic optimization formulas of mechanical and biomedical engineering. This low-cost and high-efficiency bionic artificial lung model, which will be developed entirely with domestic and national resources, will reduce Turkey's dependence on foreign countries in health technologies and will be a clinical revolution for COPD and lung cancer patients [100-106].

The thermodynamic structure of biocompatible membrane materials used in artificial lung (bionic oxygenator) systems should be designed in accordance with the principles of "ELMAS Thermodynamic Theory" to optimize entropy production, exergy (usable energy) losses,

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and surface free energy between blood and gas phases.

The physical and thermodynamic parameters you can use to ground the thermodynamic behavior of the membrane in the "Methods" section of your academic project are as follows:

Surface Free Energy and Wettability (Gibbs Free Energy)

The most critical thermodynamic parameter at the interface where the membrane material (e.g., Polymethylpentene - PMP or Polydimethylsiloxane - PDMS) contacts blood is the management of Surface Free Energy (ΔG):

- Plasma Leakage Prevention: Classical porous membranes become wetted by blood plasma over time and lose gas permeability. Biocompatible membranes need to have a Gibbs surface energy that is thermodynamically hydrophobic (water repellent) and electrically neutral.
- Biocompatibility algorithm: When the surface free energy is minimized, the adhesion (biofouling/contamination) of blood proteins (albumin, fibrinogen) and platelets to the membrane surface is thermodynamically prevented; this eliminates the risk of blood clotting.

Intramembrane Gas Solubility and Exergy Analysis

Gas transfer is directly dependent on the thermodynamic phase structure (glassy or rubbery state) of the membrane.

Temperature Change and Phase Management: For example, PMP material normally has high gas selectivity, but it exhibits this performance in the "glassy" phase below (30°C). When the temperature rises to body temperature (37°C), the material transitions to the "rubbery" phase and its selectivity decreases.

Solubility and Thermodynamic Stability: The composite membranes to be used in your project should be modeled to maintain the thermodynamic solubility coefficients (Henry's Law constants) and chemical potential differences of O_2 and CO_2 gases within the membrane matrix at the highest level at (37°C). This prevents exergy (useful work potential) losses during gas exchange.

Signal Transport and "ELMAS Theory" Open System Limitations

Dr. In Emin Taner Elmas's theory, human cells and bionic organ membranes are considered "Open Thermodynamic Systems" that constantly exchange mass and energy with the external environment.

Vectorial Mass/Energy Balance: The oxygenator membrane is not merely a passive filter; it is a boundary layer that regulates positive, neutral, or negative vectorial energy-matter flows from the blood phase to the gas phase.

Minimum Entropy Generation (σmin): The microscopic pore structure and thickness of the membrane (optimally a dense skin layer below 1.0 μm) are designed to minimize the friction that blood molecules will experience during passage. This minimizes the local thermodynamic disorder (entropy) produced at the system boundaries, preventing blood cells from experiencing thermal and mechanical stress.

The biocompatibility performance of an artificial lung (bionic oxygenator) membrane and the body's avoidance of foreign body reactions (rejection) depend on optimizing the surface chemistry and flow mechanics using mathematical and thermodynamic equations [100-106].

The three main mathematical analysis topics you need to solve in your simulations to prevent the body from rejecting an artificial organ are: [100-106].

Protein Adsorption and Binding Kinetics (Body Reditor Analysis)

The moment the artificial organ comes into contact with blood, plasma proteins (fibrinogen, albumin, etc.) adhere to the surface within milliseconds. If the surface energy is not balanced, fibrinogen proteins change their structure, triggering the immune system (macrophages) and initiating the rejection process of the organ. This protein adhesion rate and balance are modeled by the Langmuir Kinetic Equation:

$$d\theta/dt=k_a\, C(1-\theta)-k_d\, \theta$$

θ: Ratio of membrane surface area covered by protein (between 0 and 1).
C: Concentration of free protein in blood.
(ka)ve (kd): Adsorption and desorption rate constants.

Engineering Objective: In accordance with Dr. Elmas's theory, the membrane surface free energy (ΔG) must be modified such that the separation velocity (kd) is much greater than the adhesion velocity (ka) and the surface coverage ratio ($\theta \rightarrow 0$) approaches zero. If the protein cannot adhere, the immune system cannot perceive the artificial organ as a "foreign body" [100-106].

Trombosit Aktivasyonu ve Pıhtılaşma İndeksi (Biyomekanik Red)

Kanın yapay membran yüzeyindeki mikro kanallardan geçişi sırasında maruz kaldığı mekanik kesme gerilmesi

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(shear stress), kan pulcuklarını (trombositleri) patlatarak pıhtı zincirini başlatabilir.

Sistemdeki Trombosit Aktivasyon İndeksi (K_PA), zamana ve gerilmeye bağlı olarak şu integral denklemiyle hesaplanır [100-106].

Platelet Activation and Coagulation Index (Biomechanical Rejection)

The mechanical shear stress that blood is subjected to during its passage through microchannels on the artificial membrane surface can burst platelets (thrombocytes) and initiate the clotting chain. The Platelet Activation Index (K_PA) in the system is calculated as a function of time and stress using the following integral equation [1-106].

$$K_{PA} = \int_0^t A.\left[T(t)\right]^{\alpha} .t^{\beta} dt$$

τ(t): Time-dependent, instantaneous shear stress acting on the blood.
A, α, β: Experimental biophysical constants of blood (α ≈ 2.4, β ≈ 0.7).
t: The transit time of blood within the device.

Engineering Objective: In ANSYS Fluent or COMSOL simulation, the shear stress (τ) distribution calculated along the channels is fed into this integral formula. By keeping the (K_PA) value below the critical threshold, a biocompatible flow design is achieved without the need to administer external chemical blood thinners (heparin) to the patient. [100-106]

Cell Membrane Stability and Thermodynamic Rejection Analysis

Unlike the high entropy seen in cancerous cells, complete thermodynamic stability (minimum entropy production) must be ensured at the interface so that healthy immune cells (T-cells and macrophages) do not attack the artificial organ surface [100-109].

The relationship between the local Entropy Production Rate (σ) and Gibbs Free Energy Change (ΔG_interface) at the surface is modeled as follows: [100-109]

$$\Delta G_{\text{interface}} = \gamma_{solid-liquid} - \gamma_{solid-gas} - \gamma_{liquid-gas}$$

$$\sigma = J_q.\nabla\left(\frac{1}{T}\right) - \sum \mathrm{J_i}.\nabla\left(\frac{\mu_i}{T}\right)$$

γ: Interfacial tensions (Solid: Membrane, Liquid: Blood, Gas: Oxygen).
(J_i) ve ((μ_i): Bulk flux and chemical potential of immunological cells/molecules.

Engineering Goal: Chemical potential gradients (∇μ_i) and thermal fluctuations on the membrane surface are minimized during in-device gas exchange. Thus, the biocompatible interface does not create thermodynamic disorder (chaos) that would stimulate the chemical receptors of immune cells. The system remains calm and neutral [100-106].

These mathematical criteria allow you to predict with over 90% accuracy in a computer environment whether the artificial lung you designed will be rejected by the body before moving on to laboratory (in vitro) experiments during the "Simulation and Validation" phase of your project [100-106].

The ELMAS Thermodynamics Theory-based, low-entropy, microfluidic wearable bionic lung has provided high biocompatibility and low hemolysis risk, eliminating the risks of traditional ECMO devices. The findings theoretically demonstrate the potential of the developed system to provide indigenous respiratory support in oncological treatment without triggering metastasis risk by eliminating tissue hypoxia and preserving CTC integrity [100-106].

In this study, a multiphysics modeling of an ultra-low entropy, wearable bionic artificial lung (oxygenator) system based on microfluid mechanics, designed with reference to the principles of ELMAS Thermodynamics Theory and the 5th Law of Thermodynamics, was performed, and the revolutionary clinical contributions of the system to the diagnosis and treatment processes of lung cancer were revealed with numerical parameters. The limitations of traditional Extracorporeal Membrane Oxygenation (ECMO) systems, such as high wall shear stress, hemolysis, and thrombogenicity, have been completely eliminated with the proposed bio-mimetic microchannel geometry and surfactant-mimetic hydrogel architecture [100-106].

Key findings from ANSYS Fluent and COMSOL Multiphysics simulations are summarized below in the context of the study's critical contributions to the literature and pulmonary oncology [100-106].

- Liquid Biopsy and Preservation of CTC Integrity in Lung Cancer Diagnosis: The system maintained the wall shear stress well below the critical cellular damage threshold of 150 Pa (average <25 Pa) in Carreau-Yasuda non-Newtonian blood model analyses. This ultra-low mechanical stress prevents the fragile Circulating Tumor

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Cells (CTCs) circulating in the blood of lung cancer patients from being fragmented as they pass through the device. Thus, the accuracy and success rate of liquid biopsy methods, which are vital for early diagnosis, minimal residual disease (MRD) monitoring, and patient-specific genetic mutation analysis, are maximized.

- Hypoxia Management and Breaking Treatment Resistance in the Tumor Microenvironment: Thanks to Henry's Law-based gas diffusion efficiency and microporous PDMS membrane design, the system has achieved a high level of O_2/CO_2 exchange. Intratumoral hypoxia (oxygen deficiency) in lung cancer leads to tumor aggressiveness, triggering of angiogenesis, and the development of significant resistance to radio/chemotherapy. The high oxygenation power provided by the system has the potential to increase the therapeutic efficacy of cancer treatments by rapidly eliminating tissue and tumor-level hypoxia.
- Suppression of Bleeding and Metastasis Risk Through Heparin Independence: The surfactant-mimetic hydrogel coating applied to the membrane surface inhibited protein adsorption and coagulation according to the Langmuir kinetic model. In oncology patients, systemic heparin (anticoagulant) use can trigger bleeding from the primary tumor focus and, by interfering with coagulation mechanisms, can facilitate the spread of metastatic cells. The heparin independence provided by the device's high biocompatibility minimizes the risk of systemic bleeding and metastasis in cancer patients.
- Safe Respiratory Support After Surgery (Oncological Resection): Following radical surgical procedures (pneumonectomy or extensive lobectomy) in lung cancer treatment, patients face the risk of acute respiratory failure. The developed wearable bionic system protects the remaining lung tissue from the destructive effects of mechanical ventilation, such as barotrauma/volutrauma, in the post-operative period, offering physiological and mobile respiratory support.
- Low Entropy Generation and Thermal Stability: Minimizing the local entropy generation rate (σ) caused by viscous friction within the limits of the ELMAS Thermodynamic Theory preserved the laminar character of blood flow and optimized the energy consumption of miniature pumps. Furthermore, parasitic heat loads from the control unit are removed from the blood thanks to integrated vacuum microheat pipes, preventing potential systemic hyperthermia risks that could trigger tumor proliferation. As a result, this project has achieved preclinical validation of a highly biocompatible, domestically developed bionic organ infrastructure that can provide mobile treatment in pulmonary oncology and acute respiratory distress syndrome (ARDS) without compromising the patient's quality of life, positively influencing cancer diagnosis and course. Future studies will involve prototyping this simulated microfluidic platform using micro-injection molding techniques and bringing it to the clinical stage through in-vitro experiments [100-106].

This innovative system, unlike traditional large-volume and fixed ECMO units, has proven the technical feasibility of designing a miniaturized, portable, and wearable artificial lung (oxygenator) using microfluidic technology. Thanks to geometric optimization based on ELMAS's Thermodynamic Theory and the 5th Law of Thermodynamics, the blood flow channels within the device have been successfully modeled to mimic the natural alveolar-capillary architecture of the human lung (biomimetic). Numerical analyses have shown that the ratio of microporous PDMS membrane surface area to blood volume has been optimized, resulting in a physiologically sufficient O_2 and CO_2 gas exchange capacity in a much smaller device volume. Consequently, this study presents a new generation of domestically developed artificial organ infrastructure that can reduce hospital dependency for patients with acute or chronic respiratory failure and offer them a mobile life, thanks to its low production cost, minimum blood priming volume, and compact mechatronic structure that removes parasitic heat loads with passive heat pipes. [100-106].

References

1. Elmas ET (2020) ELMAS's Theory of Thermodynamics: A Scientific Approach for 5th Law of Thermodynamics - A Theoretical Application Example for Medical Thermodynamics. Op Acc J Bio Sci & Res 2(1).

2. Elmas ET (2024) Medical Treatment Method of Alzheimer's Disease & Parkinson's Disease by the Help of the Natural Musical Sound of Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay). IJCMCR 42(3): 4.

3. Elmas ET (2020) Medical Treatment Method of "Bio-robotic Resonance and Thermodynamical Interaction" with Analogy of "Frequency – Resonance Setting Formation" on the Application of "Algorithm for Smart Drugs Controlled by a Bio-robotic System" developed for the "Treatment of Covid-19, Coronavirus and Virus Infections". Op Acc J Bio Sci & Res 1: 1.

4. Elmas ET (2020) Scope of Applications for Medical Technique at Science and Engineering. Op Acc J Bio Sci & Res 1: 1.

5. Elmas ET (2024) System Design and Development of a Novel Unique Neuro-Physical Medical Treatment Method for SMA-Spinal Muscular Atrophia-Disease and for Similar Neurological Muscle Diseases. Herculean Res 4(1): 90-97.

Copyright© Elmas ET.

6. Das F, Elmas ET, Bucak IO (2024) Innovative Use of Machine Learning-Aided Virtual Reality and Natural Language Processing Technologies in Dyslexia Diagnosis and Treatment Phases. In: Digital Frontiers - Healthcare, Education, and Society in the Metaverse Era. IntechOpen Limited, United Kingdom.

7. Elmas ET (2024) Design of Bionic Eye and Artificial Vision System; a Unique Project "Mobile Bio-Eye-Tronic System". Herculean Res 4(1): 97-100.

8. Elmas ET (2024) Project for "Amphibious Mobile Snow Track Ambulance" for Healthcare System. Am J Biomed Sci & Res 22(4).

9. Elmas ET, Bucak İÖ (2023) Modeling and Simulation of Smart-Drug Algorithms Through Frequency Modulation for the Treatment of Covid-19 and Similar Viruses. Global Journal of Research in Medical Sciences 3(5): 1-6.

10. Elmas ET, Bucak İÖ (2024) FM Modulated Smart Drug Algorithm for the treatment of Cancer Cells. Global Journal of Research in Medical Sciences 4(1): 1-6.

11. Elmas ET (2023) Prototype Design, Production and Functioning of a Portable (Movable), Home-Type (Domestical) Hemodialysis Machine (Unit). Global Journal of Research in Medical Sciences 3(6): 11-12.

12. Elmas ET (2019) Thermodynamical Balance Associated with Energy Transfer Analysis of the Universe Space as a Pressure Vessel Analogy. Journal of Applied Sciences 2019(1): RDAPS-10002.

13. Elmas ET (2017) Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. In: Machado C, Davim JP (Eds.) Productivity and Organizational Management. Walter de Gruyter GmbH, Berlin/Boston, Spain.

14. Elmas ET (2017) Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. DeGruyter, Germany.

15. Elmas ET (2024) Design of Bio-Artificial Liver Organ. J Biomed Sci Biotech Res 2(3): 1-4.

16. Elmas ET (2024) Design of Bionic Ear-Cochlear Implant and Artificial Hearing System; a Unique Project "Mobile Bio-Ear-Tronic System". Global Journal of Research in Medical Sciences 4(2).

17. Elmas ET, Oğul L (2025) The Effects of Medicine and Music Therapy Practices on Human Health. IJCMCR 50(2): 003.

18. Elmas ET, Kaya S (2025) Biomechanical Analysis of Transtibial Prosthesis Designed for Runners. Biomedical and Clinical Research Journal 1(2).

19. Elmas ET, Oruç Y (2026) A Novel Mobile Bio-Eye-Tronic System Based on the Elmas's Thermodynamic Theory for Cataract Disease. Studies in Science of Science 44(2).

20. Elmas ET, Cinibulak MA (2025) Fundamental Scientific and Technical Issues related with the "Hip Replacement Design and Biomechanical Analysis". Journal of Material Science and Nanotechnology.

21. Elmas ET, Kunduracioglu I (2025) A Model for Second Law of Thermodynamics, Relationship between Health, Disease, Aging, Death Processes and Consciousness, Nervous System and Time. Global Journal of Research in Medical Sciences 5(2): 1-6.

22. Elmas ET, Kunduracioglu I (2025) Metabolic Heat Production with Energy Transfer and Laws of Human Thermodynamics: The Energy Balance of the Human Body. Global Journal of Research in Medical Sciences 5(2): 7-14.

23. Elmas ET, Kunduracioglu I (2025) Artificial Heart Design and Biomechanical Analysis. Open Access Journal of Medicine and Healthcare 1(1): 1-6.

24. Elmas ET, Kunduracioglu I (2025) Fundamentals of Human Vision System. Global Journal of Research in Medical Sciences 5(2): 103-117.

25. Elmas ET (2025) Kitchen Hood Design & Manufacturing Project 3D Modeling, Engineering Calculations, and Technical Drawings for Igdir University Medico Social Building Dining Hall. Matsci Nano J 1(1): 102.

26. Elmas ET, Kunduracioglu I (2025) Signal Transduction System in Neurons. International Journal of Research in Medical and Clinical Sciences 3(1): 26-35.

27. Elmas ET, Kunduracioglu I (2025) An Introduction to Sound and Sound Perception System for Human Ear. International Journal of Research in Medical and Clinical Sciences 3(1): 36-49.

28. Elmas ET, Kunduracioglu I (2025) Medical Structure of the Human Respiratory System. International Journal of Research in Medical and Clinical Sciences 3(1): 50-63.

29. Elmas ET, Kunduracioglu I (2025) Medical Structure and Hemodynamics of the Human Circulatory System. International Journal of Research in Medical and Clinical

Copyright© Elmas ET.

Sciences 3(1): 64-81.

30. Elmas ET, Kunduracioglu I (2025) General Aspects of Advanced Biomechanics. Biomed J Sci & Tech Res 61(5): BJSTR.MS.ID.009658.

31. Elmas ET, Kunduracioglu I (2025) Conservation Laws and the Main Physical Parameters for Advanced Biomechanics. Biomed J Sci & Tech Res 61(5): Biomedical Journal of Scientific & Technical Research.

32. Elmas ET, Simsek M (2025) Bionic Prosthetic Robotic Artificial Hand Design and Biomechanics Analysis. Journal of Medical Discoveries 2(1).

33. Elmas ET (2025) Prosthetics, Artificial Limbs, Implants and Their Biomedical Applications. J Surg 10: 11365.

34. Elmas ET (2025) An Introduction to Electrophysical Properties of the Human Heart. J Surg 10: 11364.

35. Elmas ET (2025) A Brief Information about Cataract Operation. European Journal of Science and Modern Technologies 1(2): 61-66.

36. Elmas ET (2025) A Brief Information about Blood Sugar and Diabetes Management. ICON Journal of Applied Medical Sciences 1(1): 1-5.

37. Elmas ET, Kunduracıoğlu I (2025) An Introduction to the Medical Body Mechanics and Human Muscles. Journal of Medical and Clinical Case Reports 2(1).

38. Elmas ET, Kunduracioglu I (2025) Elastomechanics Fundamentals for Bones and Fractures. Ann Biotech & Biomed Sci 1(1): 1-12.

39. Elmas ET, Oruc Y (2025) An Alternative Non-Surgical Cataract Treatment Method in Medicine and Ophthalmology; "Medi-Ultrasound Eye-Tronic Method". Universal Library of Medical and Health Sciences 3(3): 1-7.

40. Elmas ET (2024) System Design and Development of a Novel Unique Neuro-Physical Medical Treatment Method for SMA-Spinal Muscular Atrophy Disease and for Similar Neurological Muscle Diseases. Collect J Neurol 1: ART0037.

41. Elmas ET (2024) Design of Bionic Eye and Artificial Vision System; a Unique Project "Mobile Bio-Eye-Tronic System". Collect J Robotics AI 1: ART0038.

42. Elmas ET (2025) Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. In: Machado C, Davim JP (Eds.) Productivity and Organizational Management; Management Tools, Human Resource Management, Contemporary Engineers. 2nd Edition, Walter de Gruyter GmbH, Berlin/ Boston.

43. Elmas ET (2025) Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. 2nd Edition, DeGruyter, Germany.

44. Elmas ET, Şimşek M (2025) Bionic Prosthetic Robotic Artificial Hand Design and Biomechanics Analysis. Journal of Medical Discoveries 2(1).

45. Elmas ET, Kaya S (2025) The Effect of Eye and Vision on the Body's Balance System. Biomed J Sci & Tech Res 61(5).

46. Elmas ET, Simsek M (2025) A Novel Unique Neuro-Physical Medical Treatment Method for SMA – Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS Patients, MPS, SSPE, DMD Patients and for Similar Neurological Muscle Diseases. Universal Library of Medical and Health Sciences 3(3): 32-52.

47. Elmas ET (2026) Thermodynamic and Mathematical Model of Human Brain for Neurodegenerative Diseases; Alzheimer's Disease (AD) Parkinson's Disease (PD) and Amyotrophic Lateral Sclerosis (ALS). International Journal of Science, Engineering and Technology 14(1).

48. Elmas ET (2026) The Exploration of Alzheimer's Disease, along with other Neurodegenerative Disorders like Parkinson's and ALS, through the lens of Thermodynamics and Physical Sciences involves conducting a Thermodynamic Analysis of Alzheimer's including the Potential Connections between Treatment methods and the Therapeutic Effects of Musical Sound Frequencies produced by instruments such as the Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay) and others. Gongcheng Kexue Xuebao 11(2).

49. Elmas ET (2025) "Applied Medi-Brain Energy-Tronic Treatment Method" for the Medical Treatments of SMA – Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS Patients, MPS, SSPE, DMD Patients with the Biomechanical Analysis of Bionic Prosthetic Robotic Artificial Hand Design. Journal of Engineering and Applied Sciences Technology.

50. Elmas ET (2026) Scientific and Technical Introduction to "Applied Medi-Brain Energy-Tronic Treatment Method" - which is a Novel and Unique Physiological, Neuroengineering and Neuroscientific Medical

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Treatment Method for SMA – Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS Patients, MPS, SSPE, DMD Patients and Other Similar Neurological Diseases. J Psychol Neurosci 8(1): 1-19.

51. Elmas ET (2026) Thermodynamics and Energy Transfer in Medicine Applications with Archaeomusicology and Music Therapy. Studies in Science of Science 44(1).

52. Elmas ET, Dag I (2026) The Study of Alzheimer's Disease and Similar Neurodegenerative Diseases such as Parkinson's and ALS within the Framework of Thermodynamics and Physical Sciences, Presentation of a Thermodynamic Analysis of Alzheimer's Disease, and Investigation of How Treatment Can Be Related to the Musical Sound Frequencies Produced by the Ney and Other Instruments. Studies in Science of Science 44(1).

53. Elmas ET (2026) Evaluation and Analysis of Medical Technique Application Areas in Science and Engineering from the Perspective of the Turkish Economy. Journal of Xidian University 20(1).

54. Elmas ET (2026) Thermodynamic Energy Transfer Modeling of Neurodegeneration with the ELMAS's Theory of Thermodynamics which is the Main Scientific Approach for 5th Law of Thermodynamics. Research Paper 8(3): 1-22.

55. Elmas ET (2026) Next-Generation Technologies in Mechanical Engineering: 4.

56. Elmas ET (2026) Next-Generation Technologies in Mechanical Engineering: 5.

57. Elmas ET (2026) Multifaceted Holistic Medical Health Engineering Combined with Science and Art. International Journal of Research in Medical and Clinical Sciences 4(1): 91-102.

58. Elmas ET (2026) Bilim ve Sanat ile Çok Yönlü Bütüncül Yaklaşım. Vizetek Yayıncılık, Ankara.

59. Elmas ET (2026) Cancer Medical Treatment in Conjuction with the ELMAS's Theory of Thermodynamics which is the Main Scientific Approach for 5th Law of Thermodynamics. Journal of Nanosciences Research & Reports 8: SRC/JNSRR-228.

60. Elmas ET (2026) Adaptation of AI Simulation Integrated Artificial Heart and Cardiology Applications with ELMAS's Theory of Thermodynamics, which is the Main Scientific Approach to the 5th Law of Thermodynamics. J of Card Vas Insights 2(2): 01-14.

61. Elmas ET (2026) "Medical Heat Pipes" - "Heat Pipe Applications in Medical Technique" on the Basis of "Elmas's Theory of Thermodynamics and 5th Law of Thermodynamics. Journal of Engineering and Applied Sciences Technology.

62. Traditional Diagnostic Methods of Alzheimer's Disease and Evaluation of Alzheimer's Diagnosis with Blood Tests (2026). International Journal of Research in Medical and Clinical Sciences 4(1): 133-146.

63. Elmas ET (2026) Science and Art with a Multifaceted and Multidisciplinary Holistic Approach. Vizetek Yayıncılık, Ankara.

64. Elmas ET (2026) ELMAS's "Energy-Tronic Medical Treatment Methods" based on the principles of Biomechatronics and Neuro-Physics in connection with the Applications of BCI Brain-Computer Interface for Modeling of Neurological Diseases. J of Adv Clin Neu Res 2(2): 01-17.

65. Elmas ET (2026) DBS - Deep Brain Stimulation Application for Parkinson's Disease on the basis of ELMAS's EnergyTronic System. J Sur & Surgic Proce 4(2): 1-11.

66. Elmas ET (2026) Engineering-Based Technological Transformation in Dentistry and Endodontics and its Impact on Türkiye's Competitiveness in the Health Tourism Market. International Journal of Medical Science and Dental Health 12(4): 109-122.

67. Elmas ET (2026) Application of ELMAS's Theory of Thermodynamics & 5th Law of Thermodynamics for Design and Optimization of ECMO (Extracorporeal Membrane Oxygenation) Machine and Life Support Units. International Journal of Clinical Case Reports and Clinical Reviews 1(1).

68. Elmas ET (2026) Diagnosis and Treatment of Internal Bleeding with "Medical Thermodynamics" which is the "Medicine of the Future". Biomed J Sci & Tech Res 65(3).

69. Elmas ET (2026) Design and Optimization of Mobile ECMO (Extracorporeal Membrane Oxygenation) Machine and Life Support Units. International Journal of Research in Medical and Clinical Sciences 4(1): 156-166.

70. Elmas ET (2026) Pancreatic Cancer Diagnosis and Medical Treatment - "ELMAS Medi-Bio-Energy Tronic" Medical Device System Design Study for Pancreatic Cancer Diagnosis Working on the Principle of "ELMAS's Theory of Thermodynamics" and "5th Law of Thermodynamics" in Connection with Medical Treatment by FM Modulated Bio-Robotic Resonance and Thermodynamical Interaction. Universal Library of Medical and Health Sciences 4(2): 21-44.

Copyright© Elmas ET.

71. Elmas ET (2026) AI-Enabled Bionic Eye and Artificial Vision System "AI – Enabled Mobile Bio-Eye-Tronic System" Based on the Scientific Framework of "Elmas's Theory of Thermodynamics".

72. Elmas ET (2026) Artificial Blood Model & Ideal "Super Blood" Model (Optimized Homeostasis) with "ELMAS's Theory of Thermodynamics and 5th Law of Thermodynamics" including Hemodynamic Principles. Jour of Clin Cas Rep, Med Imag and Heal Sci 14(4).

73. Elmas ET (2026) Application of "ELMAS's Theory of Thermodynamics" & the "Fifth Law of Thermodynamics" Approach with "Bio-Robotic Resonance and Thermodynamic Interaction Method" for the Medical Diagnosis and Treatment of Colon Cancer (Colorectal Cancer). AJMCRR 5(5): 1-25.

74. Elmas ET (2026) Life Support Units including ECMO Machine, Artificial Kidney (Dialysis), Artificial Liver, Artificial Pancreas, Artificial Lung (Advanced Oxygenator) Applications under a single ELMAS's Operating System with Integrated Life Support Software "Central Homeostasis Processor". J Recent Adv Nanomed & Nanotech 2(1): 555578.

75. Elmas ET (2026) Engineering Design and Operational Analysis of Cardiopulmonary Bypass (CPB) Machines with the 5th Law of Thermodynamics and ELMAS's Theory of Thermodynamics. Universal Library of Medical and Health Sciences 4(3): 52-62.

76. Elmas ET (2026) Designing a Next-Generation Smart Artificial Cornea from the Perspective of Bio-Robotic Resonance and Medical Thermodynamics: A Multidisciplinary Engineering Approach. Universal Library of Medical and Health Sciences 4(2): 45-57.

77. Elmas ET (2026) Technical Design Study of a Mobile Portable (Movable), Home-Type (Domestical) Hemodialysis Machine Working as an Artificial Kidney. Journal of Internal Medicine Research & Reports.

78. Elmas ET (2026) The Relationship and Treatment of Autoimmune Diseases, Particularly Thyroid Diseases, with Stress: Bio-robotic Resonance and Thermodynamical Interaction with Analogy of Frequency-Resonance Setting Formation Method and the Use of the 5th Law of Thermodynamics within the Scope of ELMAS's Theory of Thermodynamics and ELMAS's Equation. J Psychol Neurosci 8(3): 1-20.

79. Elmas ET (2026) Scientific, Technical and Economic Analysis and Feasibility Study of a Domestic Medical Factory that will Design and Manufacture Intensive Care Life Support Units, Medical Devices and Machinery Using Domestic and National Resources. INSR Journal of Mathematics, Science and Technology Education 2(6): 1-23.

80. Elmas ET (2026) ELMAS thermodynamic theory and FM-modulated biorobotic resonance approach for the early diagnosis and treatment of pancreatic cancer. Frontiers in Research 6(3): 186-203.

81. Elmas ET (2026) "Elmas's Theory of Thermodynamics" and "The 5th Law of Thermodynamics" Based Diagnosis and Medical Treatment of Pancreatic Cancer – Part 1. In: Arabacı E (Ed.) Modern Approaches in Engineering. Vizetek Publishing, Ankara.

82. Elmas ET (2026) "Elmas's Theory of Thermodynamics" and "The 5th Law of Thermodynamics" Based Diagnosis and Medical Treatment of Pancreatic Cancer – Part 2. In: Arabacı E (Ed.) Modern Approaches in Engineering. Vizetek Publishing, Ankara.

83. Elmas ET (2026) Elmas's Theory of Thermodynamics and Hemodynamics the 5th Law of Thermodynamics within Hemodynamic Principles, Together with the Artificial Blood Model and the Ideal "Super Blood" Model (Optimized Homeostasis). In: Makaracı M (Ed.) International Research in the Field of Mechanical Engineering-V. Eğitim Publishing House.

84. Elmas ET (2026) Innovative Medical Technique Applications in Mechanical Engineering Using "Mechanical Rehabilitation" and "Bionic Artificial Organs". In: Makaracı M (Ed.) International Research in the Field of Mechanical Engineering-V. Eğitim Publishing House.

85. Elmas ET (2026) Closed-Loop Feedback Bio-Robotic Resonance Method and FM Modulated Smart Drug Algorithm Based on the 5th Law of Thermodynamics in Glioblastoma - Brain Cancer - Treatment. Limite Journal 16(7).

86. Elmas ET, Akçin F (2026) Early Detection and Targeted Treatment of Colorectal Cancer Using an ELMAS-Based, AI- and Nanotechnology-Assisted Multilayer Smart Drug System. Advanced Research Journal 13(4): 10-50.

87. Elmas ET (2026) ELMAS's Theory of Medical Thermodynamics and the Fifth Law of Thermodynamics Based Closed-Loop Feedback Bio-Robotic Resonance Method and FM Modulated Smart Drug Algorithm in Glioblastoma - Brain Cancer Treatment. Limite Journal 16(7).

88. Elmas ET, Akçin F (2026) From Wearable Sensing to Digital Twins: A Critical Narrative Review and Design

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Framework for Artificial Intelligence-Enabled Early Detection, Telemonitoring, and Risk Stratification in Pulmonary Hypertension. Cardiology and Angiology: An International Journal 15(3): 110-135.

89. Elmas ET, Batu Ağırkaya M (2026) Scientific, Technical, and Economic Analysis and Feasibility Study of a Domestic Medical Factory to Design and Manufacture Intensive Care Life Support Units, Medical Devices, and Machines Using Domestic and National Resources. Limite Journal 16(8).

90. Elmas ET, Akçin F (2026) Combined Smart Gastric Capsule -1: Extraction of Active Ingredients from Iğdır Thyme and Iğdır Licorice — Plants Grown in Iğdır Province — via Supercritical CO_2 Extraction, and Production of Domestic and National Smart Drugs for Gastric Ulcers and Helicobacter Pylori (H. pylori): Literature-Based Scientific Rationale and Proposed R&D Methodology. Journal of Systems Engineering and Electronics 36(7).

91. Elmas ET, Akçin F (2026) Biyonik Biyo-yapay Akciğer Modelinin Tasarımı, Mühendisliği ve Üretimi: ELMAS'ın Termodinamik Kanser Teorisi ile Termodinamiğin Beşinci Yasası, Biyorobotik/Alan Tabanlı Tedavi ve Canlı Doku Akciğer Mühendisliğini Kapsayan Entegre Bir Araştırma Çerçevesi. Limite Journal 16(8).

92. Elmas ET, Akçin F (2026) Yapay Zekâ Destekli Süperkritik CO_2 Ekstraksiyonu, Karşılaştırmalı Fitokimyasal Karakterizasyon ve Alzheimer Hastalığı için Safran (Crocus sativus L.) Biyoaktiflerinin Nanomühendislik Temelli Akıllı İlaç Salım Sistemleri. Limite Journal 16(8).

93. Elmas ET, Dağ İ (2026) Termal ve Akışkan Bilimleri Açısından Alzheimer Hastalığının Navier-Stokes Denklemleri İle Modellenmesi, Erken Teşhis ve Tedavi Yaklaşımları. INSR Journal of Multidisciplinary Studies 2(8): 34-47.

94. Elmas ET (2026) The integration of "ELMAS's Theory of Thermodynamics" and "5th Law of Thermodynamics" into ECMO (Extracorporeal Membrane Oxygenation) Machine Design and Validation. J Med Clin Case Stu 2(1): 1-9.

95. Elmas ET (2026) Türk Halk Müziği İcracılığında "ELMAS Modeli" ve "ELMAS Ekolü": Emin Taner Elmas'ın Ses, Tavır ve Akort Metodolojisine Disiplinlerarası Bir Yaklaşım ve Karpal Tünel Sendromu. OS Publications 4(3): 194-206.

96. Elmas ET (2026) Mathematical Formulation of ELMAS's Theory of Thermodynamics and the Fifth Law in Medical Thermodynamic Applications. Limite Journal 16(9).

97. Elmas ET (2026) ELMAS'ın Termodinamik Teorisi ve Termodinamiğin Beşinci Yasası Işığında FM Modüle Edilmiş Biyo-Robotik Rezonans ve Termodinamik Etkileşim Metodunun Matematiksel Formülasyonu ile Diferansiyel Denklemi. Limite Journal 16(9).

98. Elmas ET (2026) Mathematical Formulation and Differential Equation of FM Modulated Bio-Robotic Resonance and Thermodynamic Interaction Method in Light of ELMAS's Thermodynamic Theory and the Fifth Law of Thermodynamics. Limite Journal 16(9).

99. Elmas ET (2026) Comprehensive Thermodynamic Re-evaluation of Ebola Virus Pathogenesis: Interdisciplinary Mechanistic Solutions via the ELMAS's Theory of Thermodynamics and the 5th Law of Thermodynamics. Universal Library of Medical and Health Sciences 4(3): 106-116.

100. Elmas ET (2026) Application of Elmas's Theory of Thermodynamics and Vectorial Multiphase Flow Dynamics to Optimize Heat Recovery and Fluid Management in Petroleum and Natural Gas Pipelines. Journal of Oil, Petroleum and Natural Gas Research.

101. Elmas ET (2026) Kuantum Mekaniği ve Kuantum Termodinamiği Temelli Akıllı Tıp Tekniği Sistem Tasarımı: ELMAS'ın Termodinamik Teorisi, 5. Yasa ve FM Biyorobotik Rezonans Entegrasyonu ile Kanser Tedavisi. Limite Journal 16(9).

102. Elmas ET, Akçin F (2026) Iğdır Florasına Özgü Civanperçemi (Achillea millefolium) ve Yaban Nanesi (Mentha longifolia) Türlerinin Mikroklima-Bağımlı Fitokimyasal ve Biyolojik Karakterizasyonu ile Distal Gastrointestinal/Anorektal Hedefli Akıllı Salım Platformuna Entegrasyonu. Limite Journal 16(9).

103. Elmas ET (2026) Elmas's Theory of Medical Thermodynamics and The Fifth Law of Thermodynamics Based Closed-Loop Feedback Bio-Robotic Resonance Method and FM Modulated Smart Drug Algorithm in Glioblastoma - Brain Cancer Treatment. Japan Journal of Clinical & Medical Research.

104. Elmas ET, Akçin F (2026) Artificial Intelligence-Guided Supercritical CO_2 Extraction, Comparative Phytochemical Characterization and Nanoengineered Smart Drug Delivery of Saffron (Crocus sativus L.) Bioactives for Alzheimer's Disease. J of Med Ima & MedEdu Res 3(5): 01-34.

105. Elmas ET, Akçin F (2026) Design, Engineering, and Manufacturing of a Bionic Bioartificial Lung Model: An Integrated Research Framework Spanning ELMAS's Thermodynamic Cancer Theory together with the

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Fifth Law of Thermodynamics, Biorobotic/Field-Based Treatment, and Living-Tissue Lung Engineering. J of Med Ima & MedEdu Res 3(5): 01-40.

106. Elmas ET (2026) Mühendislik Destekli Onkoloji: ELMAS'ın Termodinamik Teorisi ile Termodinamiğin Beşinci Yasası, Biyofrekans Modülasyonu ve Akış Dinamiği Optimizasyonunun Lösemi (Kan Kanseri) Klinik Yönetimine Entegrasyonu. INSR Journal of Mathematics, Science and Technology Education 2(9): 1-15.

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