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The Modern Microbiota Revolution

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ABSTRACT

This paper presents a comprehensive and novel vision of the Modern Microbiota Revolution, in which microorganisms are transformed from passive biological elements into intelligent engineering systems capable of meaningfully improving human life. This vision leverages the biological principles of microorganisms — including their metabolic and excretory processes — and integrates them with environmentally friendly, cost-effective, and sustainable technologies applicable to fields such as construction materials, infrastructure, and modern automotive systems. Specifically, the framework proposes the development of self-healing materials and systems in paints, asphalt, and water pipes, as well as biologically inspired energy-transfer mechanisms modelled on chloroplasts. Through the integration of calcium carbonate-precipitating bacteria, biologically inspired energy-transport systems, and protective living layers in water networks and infrastructure, this research opens new horizons for designing sustainable technologies that reduce resource consumption, protect the environment, and enhance the performance and efficiency of vehicles and public utilities. Beyond the theoretical level, this paper proposes innovative application mechanisms to serve as a cornerstone for a future in which microorganisms function as practical, intelligent elements within infrastructure and modern technology, achieving a synthesis of microbial vitality, sustainability, and efficiency.

INTRODUCTION

Despite rapid advances in modern technology, many engineering and industrial fields continue to rely on traditional solutions characterised by high resource consumption, the need for continuous maintenance, and frequent human intervention. Problems such as road cracking, uneven tyre wear, paint damage, water pipe corrosion, reduced vehicle system efficiency, and increased environmental impact remain significant challenges for contemporary societies.

In contrast, nature has operated for millions of years with highly efficient and precise systems. Quantum mechanics, for example, describes how a photon entering a chloroplast travels through all possible pathways and selects the most energetically efficient one. Nature similarly relies on microorganisms with remarkable self-repair capabilities, reorganising, adapting, and rebalancing along the shortest available path. In chloroplasts, energy and information transfer occurs with minimal loss.

Despite their importance, microorganisms have historically been viewed as isolated biological elements, detached from everyday engineering applications. This represents a significant missed opportunity, as the mechanics of nature offer substantial lessons for improving how we live. This research is grounded in a fundamental idea: that the microbiota is not merely part of the ecosystem, but can be considered an intelligent engineering tool when repurposed in a scientifically organised and safe manner. By understanding the metabolic and excretory mechanisms of microorganisms, they can be leveraged to develop more efficient, less expensive, and more environmentally friendly materials and systems, thereby reducing reliance on complex or polluting industrial solutions.

This study presents a novel vision for the utilisation of microorganisms across various fields, including self-healing paints, crack-resistant asphalt, water pipe protection, tyre self-repair, and the efficient transmission of information in modern vehicles — inspired by chloroplasts. It also examines the self-repair of tyre and asphalt cracks through the integration of bacteria capable of precipitating calcium carbonate, forming protective biolayers that prevent cracking and offer a revolutionary alternative to traditional repair methods. This vision does not aim to replace modern technology, but rather to enhance it through simple and intelligent integration of biological systems and engineering techniques, enabling the development of self-healing materials that are durable, resilient, and environmentally friendly.

RESULTS

Practical Section: The Microbiota as an Applied Engineering System

This section moves from a theoretical framework to direct practical application, treating microorganisms as functional units that can be integrated into specific engineering systems, performing clear and intended roles. This approach does not rely on the random use of microorganisms, but rather on the selection of known, non-pathogenic species that have been studied for their metabolic and excretory behaviour and their ability to adapt within closed and controlled environments.

First: Calcium Carbonate-Precipitating Bacteria and Self-Repair Applications in Industrial Materials

Bacteria capable of precipitating calcium carbonate represent some of the most promising applied models in this approach. Among the most well-known are Bacillus spp., particularly Sporosarcina pasteurii. These bacteria can survive in spore form for extended periods. When moisture and suitable conditions are present, they secrete calcium carbonate as a direct result of their metabolic processes.

Application 1 — Self-Healing Paints: In this model, bacterial spores are incorporated into fine microcapsules added to the paint. When microscopic cracks appear on the paint surface, moisture enters and breaks the thin capsule wall. The bacteria then become active and secrete calcium carbonate, filling the crack and restoring surface integrity. This application extends the paint's lifespan and reduces the need for frequent repainting, particularly in harsh environments.

Second: Applications of Bacteria in Asphalt and Infrastructure

The same principle can be applied to asphalt and concrete. Bacterial capsules are incorporated into road layers; when cracks appear due to pressure or temperature changes, they are activated upon contact with water and secrete calcium carbonate, which gradually seals the cracks. This approach reduces the development of small cracks into potholes, extends the lifespan of roads, and lowers government maintenance costs.

Third: Protective Biological Layers in Water Pipes

In water networks, pipe corrosion and pollutant accumulation pose both health and economic risks. Certain types of beneficial, non-pathogenic bacteria — such as Bacillus subtilis and non-pathogenic strains of Pseudomonas — are capable of forming protective biofilms, preventing the adhesion of harmful bacteria, and reducing internal pipe corrosion. The application mechanism involves using the bacteria within the inner layers of the pipes, then disinfecting the water before it reaches the consumer. In this way, bacteria serve as a protective tool with no direct presence in the drinking water.

Fourth: Microbiota Applications in Automotive Systems

In automotive systems, microbiota can be employed within surrounding materials, though not in combustion chambers or critical mechanical components. A practical example involves incorporating calcium carbonate-precipitating bacteria into rubber layers. When micro-cracks occur, bacteria such as Sporosarcina pasteurii become activated by moisture — for instance, when the rubber is sprayed with water for cooling purposes — and repair the damage. This application opens the door to developing safer and longer-lasting tyres.

Fifth: Biological Inspiration in Energy and Information Transfer

Moving beyond the direct use of organisms, this research also draws inspiration from the highly efficient energy-transfer mechanisms found in chloroplasts, where energy is transferred between precisely organised protein complexes with minimal loss. This principle can be translated into synthetic materials that mimic the same protein organisation found in chloroplasts. When cooled to temperatures that approximate chloroplast conditions, these materials can efficiently transfer information through molecular channels that reduce heat loss and interference.

The Role of Bacteria in Protecting Overground and Submarine Cables

Terrestrial or aquatic bacteria that precipitate calcium carbonate, such as Sporosarcina pasteurii, are ideal tools for protecting cables. When a cable is exposed to moisture or pressure — whether in a terrestrial or aquatic environment — bacteria trapped within the cable sheath become activated and secrete calcium carbonate. This fills microscopic cracks and restores the integrity of the cable's outer layer, preventing corrosion and mechanical damage. The result is a living, self-regenerating protective layer that reduces the need for conventional maintenance.

In addition, certain beneficial bacteria such as Bacillus subtilis are capable of preventing the growth of harmful microbes within the cable's outer sheath, maintaining the purity of inner layers, and preventing the accumulation of substances that cause interference or signal loss. When bacteria are integrated with insulating layers, they protect against corrosion, moisture, heat, and vibration, and minimise signal loss.

Protecting and Transmitting Information in Underground and Underwater Cables

This section presents a theoretical vision for future quantum information transmission through a complex structure incorporating modern physics and biological elements. The proposed system combines bacteria, multi-layered smart materials, and quantum mechanical principles to ensure maximum information delivery efficiency.

Bacteria are trapped within a bio-layer or microcapsules inside the outer sheath and are activated only when a crack occurs, preventing corrosion and maintaining the integrity of the outer sheath. A multi-layered insulating metal structure — with thicker layers in areas of high interference — completely encases the cable. Each layer serves a specific protective function: a vibration and pressure-blocking layer; a thermal interference absorption layer; and a cold gas layer pumped under high pressure to maintain the quantum entanglement of photons. Small inspection and control centres located at specific points along the cable continuously measure signal quality, enabling early detection of defects or entanglement degradation.

Bose-Einstein condensation techniques are proposed for use at transition points — for example, where the cable exits the sea onto the shore — to amplify and clarify the transmitted message without information loss or distortion.

Chloroplasts: A Living Model for Energy and Information Transfer

At the heart of every plant cell lies the chloroplast, which not only converts light into usable chemical energy but also functions as a fully integrated system for transferring energy with remarkable efficiency between specialised protein complexes. This efficiency surpasses that of many modern industrial systems. The role of quantum mechanics in explaining this high level of efficiency is significant; research has demonstrated evidence for wavelike energy transfer through quantum coherence in photosynthetic systems.

This study draws direct inspiration from this natural organisation. The design of synthetic materials and systems that mimic the same biological energy-transport mechanisms — replicating quantum entanglement properties while minimising heat loss and maximising efficiency — could enable more effective quantum behaviour within engineered systems. This vision opens the door to new engineering technologies applicable to information transmission systems in vehicles and smart equipment, enabling balanced thermal management across all components.

Cancer Treatment: Bacteria and Physics

The first proposed technology integrates physical cavitation with specific bacteria that interact with the tumour environment. Cavitation creates vapour bubbles in a liquid through decreased pressure inside the tumour and increased pressure at the device boundary, using specific waves. Carefully selected, precisely placed bacteria act as active sites within the tumour, releasing calcium carbonate or microscopic solid particles that serve as nuclei for microbubble generation when cavitation is applied. This leads to localised mechanical disruption and destruction of cancer cells. Mild cooling is incorporated to stabilise the bacteria and tumour in a specific location, providing spatial and temporal control over the therapeutic process while minimising damage to surrounding healthy tissue.

The second technology proposes a quantum therapeutic mechanism based on quantum entanglement and quantum tunnelling, facilitated by very mild cooling and selected molecules within a specific device. This technology conceptualises the tumour as a phenomenon of energy and information rather than merely as a biological mass. Using specific molecules with quantum mechanical properties, and reducing thermal noise through controlled mild cooling, it may be possible to induce non-local quantum effects that bypass tissue barriers and disrupt cancerous tissue without direct mechanical interference. The expected outcome is the collapse of the hyperproliferative state of cancer cells, generating self-produced internal heat within the tumour, a pressure differential, and potentially creating mechanical conditions for cavitation — resulting in complete tumour destruction without high external energy input.

A New Perspective: Beneficial Bacteria as a Sustainable Treatment for Diabetes, Obesity, and Hypertension

This research proposes a fundamentally different view of the role of beneficial bacteria in the context of metabolic disease. Rather than treating bacteria as mere auxiliary biological agents, this framework explores their potential as an adaptive, living therapeutic system capable of rebalancing glucose, lipid, and cholesterol levels within the human body. The core theory involves training and evolutionarily adapting bacteria within external environments that mimic the conditions of the diseased body, thereby enabling them to cope optimally with conditions such as elevated glucose, elevated cholesterol, or elevated lipids.

For diabetes treatment, beneficial bacteria are trained in a high-glucose environment at body temperature, with glucose as their sole, mobile food source. Over extended periods, beneficial genetic changes may be induced in new generations, producing a specialised microbiota capable of continuously and sustainably regulating glucose levels without ongoing medication.

For obesity treatment, bacteria are gradually exposed to complex fats over extended periods at body temperature, making mobile fat their sole food source. The resulting adapted microbiota can reduce fat absorption in the body and act as a permanent natural defence against weight gain.

For hypertension, the focus is on bacteria trained to metabolise cholesterol efficiently. Bacteria are exposed to moderate-to-high concentrations of mobile cholesterol as their sole food source for extended periods. After adaptation, they are introduced in small, carefully calculated doses, working harmoniously with the rest of the microbiota to regulate blood pressure continuously and sustainably, reducing the harmful effects of cholesterol on blood vessels.

DISCUSSION

This research presented a comprehensive and innovative vision of what may be termed the Modern Microbiota Revolution — a paradigm in which microorganisms are transformed from traditional biological elements into intelligent engineering systems applicable across multiple fields. From construction materials and infrastructure, including paint, asphalt, and water pipes, to modern automotive systems, underground and underwater cables, and innovative medical applications in the treatment of cancer, metabolic diseases such as diabetes and obesity, and hypertension, this paper explored the extensive potential of microorganisms when intelligently integrated with modern physics and engineering.

The research drew upon fundamental natural principles — such as the ability of microorganisms to self-secrete calcium carbonate and the energy and information efficiency of chloroplasts — and harnessed modern quantum phenomena such as quantum entanglement to translate these principles into practical and sustainable solutions. Four interconnected themes emerged: (1) the microbiota as an intelligent engineering system capable of becoming part of modern materials and systems to reduce maintenance, increase efficiency, and protect the environment; (2) innovation in medicine through the use of bacteria as a smart and sustainable living therapeutic system, adhering to principles of spatial and temporal control; (3) sustainability and efficiency through the harnessing of biological models such as chloroplasts; and (4) the integration of engineering, modern physics, and microbiology to deliver advanced solutions that transcend the traditional boundaries of each field.

This research represents a step towards redefining the relationship between humans, modern technology, and microorganisms, applying natural principles to develop smart, sustainable, and environmentally friendly solutions. It opens new horizons for future applications in both engineering and medicine. Nature offers a model for how to benefit from biological systems, and these solutions provide innovative approaches to achieving a balance between human needs and environmental sustainability.

MATERIALS AND METHODS

This research is entirely theoretical and conceptual in nature. No experimental work, laboratory procedures, or animal studies were conducted. The proposed frameworks are based on a systematic review of existing scientific literature and the application of established principles from microbiology, materials science, and quantum physics to novel conceptual applications. All biological species referenced — including Sporosarcina pasteurii, Bacillus subtilis, and non-pathogenic Pseudomonas strains — were selected based on their well-characterised properties described in the published literature. Proposed mechanisms for future experimental validation are described within the relevant sections of the Results.

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AUTHOR CONTRIBUTIONS

Mohamed Ibrahim El-Saeed Issa conceived the theoretical framework, developed all proposed models and mechanisms, performed the literature analysis, and wrote the manuscript.