

Structure and Properties of PluroGel®: A New Surfactant-based Biomaterial

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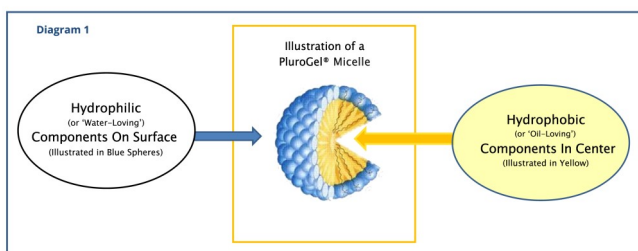
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PluroGel® is a Biocompatible, Cell-friendly, Surfactant-based Biomaterial

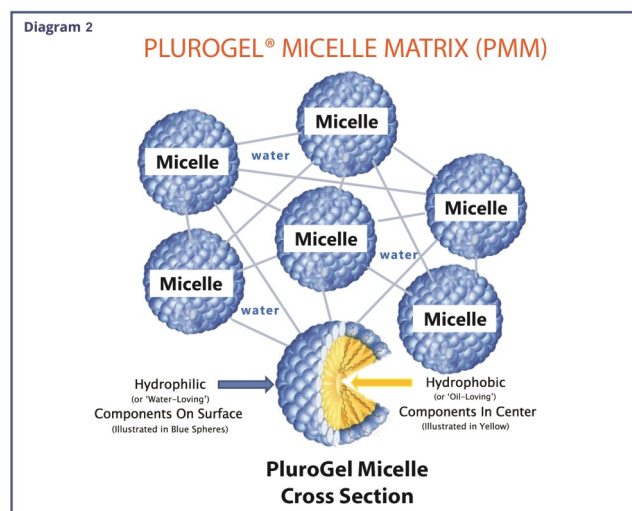
PluroGel was developed in the plastic surgery department at the University of Virginia (USA). It is beneficial in all phases of wound healing and for all tissue types. It is used routinely in burn and wound care.

PluroGel's Micelle Matrix: (PMM)

PluroGel is a biocompatible, cell-friendly¹ surfactant-based biomaterial which is a result of its unique make-up and structure. PluroGel is comprised of FDA approved, generally recognized as safe substances which have been in routine use for years in medical devices and drugs. PluroGel's surfactant component is both hydrophilic or 'water-loving' and hydrophobic or 'oil-loving'. With PluroGel's exclusive technology, this surfactant molecule in an aqueous solution forms micelles (Diagram 1)



which retain both the hydrophilic and hydrophobic regions. The hydrophilic component is on the surface of the PluroGel Micelle and the hydrophobic component is contained in the center. This results in surfactant (cleaner) properties that, uniquely for cleaners and for PluroGel, are biocompatible and cell-friendly.¹ With PluroGel's proprietary formulation technology, these micelles link to form the PluroGel Micelle Matrix (PMM). To help understand the PMM, visualize a bucket of ping-pong balls (Diagram 2).



These ping-pong balls represent the PluroGel Micelles and the space between the ping-pong balls is filled with water. The water between the PluroGel Micelles can carry water-soluble components; (such as antibiotics, antiseptics, anti-inflammatory agents, and other water-soluble biologics). The hydrophobic center of the PluroGel Micelles can carry oil-soluble materials; (such as wound exudates, denatured proteins, proteinases and other oil-soluble biologics) away from the wound. This makes PluroGel very effective for drug delivery and very supportive of the autolytic wound debridement process.

Why PluroGel is Beneficial in All Phases of Wound Healing and Tissue Types

PluroGel Products are **Multi-Function** with the Functions grouped into 3 categories:

(1) Core Functions, (2) Bio-Physical Functions and (3) Performance Functions.

The Core Functions of PluroGel result from the PMM being a water-based emulsion (an emulsion is a mixture of two substances that normally cannot mix together) of the spherical PluroGel Micelles with their hydrophilic (water-loving) and hydrophobic (oil loving) components. As a result, PluroGel is 100% water soluble for easier, faster and less painful dressing changes^{2, 3, 4, 5, 6} compared to other dressing products such as creams, ointments, oil based treatments or other dressing treatments. Wound exudate and debris is solubilized and easily rinsed off during dressing change, leaving a cleaner wound site.⁷ There is less tissue damage from the cleaning process, which aids the body's own repair process.⁸ These other products, when mixed with the wound exudate, dry out and can require physical scraping or scrubbing and in some cases, surgical intervention to remove.

PluroGel thickens as it warms, enabling it to remain on and better protect the wound. The change from room temperature to body temperature causes the PluroGel Micelles to be attracted more to each other than they are attracted to the water in the PMM. This increasing attraction between the PluroGel Micelles results in PluroGel thickening to stay on the wound. At a dressing change, as the temperature decreases from body temperature to room temperature, the PluroGel Micelles are more attracted to the water in the PMM, resulting in PluroGel becoming softer for easier, less painful and less damaging removal.

The PMM gives PluroGel its unique biocompatible and cell-friendly¹ surfactant properties. Wound cleaning begins with the application of PluroGel which affords a continuous wound cleaning process. This leads to the opportunity for cleaner, more easily assessed wounds on dressing change.⁶

The Bio-Physical Functions of PluroGel results in a moist, oxygenated, environment that facilitates wound healing.⁸ The PluroGel surfactant action has been shown to facilitate microvascular blood flow in both arterioles and venules, which otherwise in wounds, can be diminished or completely blocked due to clogging from blood clotting or wound debris.^{9, 10, 11} This apparent ability of PluroGel to maintain blood flow^{10, 11} has been shown to lead to improved tissue oxygenation in wounds.^{12, 7}

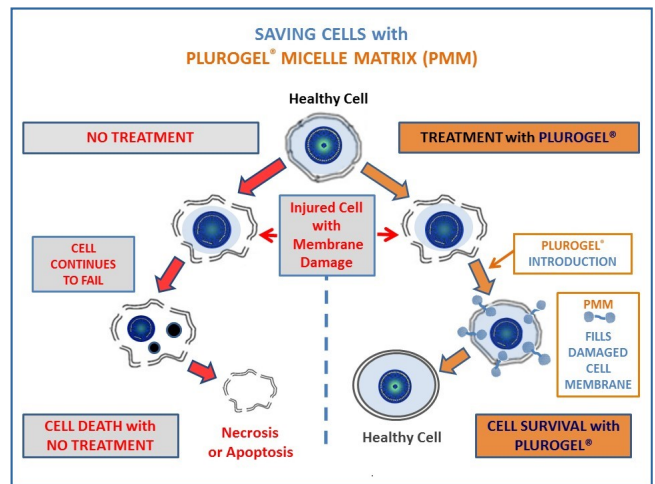
A key characteristic of PluroGel is its Bio-Physical Function of breaking up biofilm or preventing biofilm formation, which aids in wound healing. Biofilm is an oily, polysaccharide matrix that is excreted by and encapsulates the bacteria, preventing penetration by antimicrobial agents.¹³ Biofilm is thought to physically block a wound from closing. The PMM surfactant-based structure and properties allow PluroGel to penetrate the biofilm capsule and disperse the biofilm.^{14, 15} When an antimicrobial or antiseptic is present, this effect on the biofilm allows an antibiotic or antiseptic to kill the bacteria at the antimicrobial's or antiseptic's approved standard dose,^{14, 15} as opposed to published reports that antimicrobials or antiseptics must be at 4x to 1,000x stronger than their approved standard dose to kill bacteria in a biofilm.¹⁶ When the biofilm encapsulation is gone and the bacteria eradicated, the wound healing process can start.

PluroGel without antibiotic or antiseptic (PluroGel Burn and Wound Dressing) has been found to be effective against biofilm by penetrating and dispersing the biofilm. With biofilm gone, bacteria are exposed to the body's defenses such as antibodies and white cells, allowing the body to attempt eradication of the bacteria and begin the natural healing process.^{14, 15}

Publications demonstrate that the surfactant component of the PMM may have the ability to restore denatured proteins.^{17, 18} It has also been reported that the surfactant component of the PMM may enhance the delivery of selected agents into target cells by affecting the micro-viscosity of the cell membrane.^{19, 20, 21, 22, 23}

Research indicates that the PMM may fill the breaks or "holes" created in damaged cell membranes which reduces or stops intracellular material leaking through

the holes into the wound tissue.^{24, 25, 26, 12} This "plugging" of the holes in damaged cell membranes can aid the body in cell repair and consequently, cell survival (Diagram 3). Research further indicates that



the PMM is "squeezed out" of the cell membrane as the cell repairs the breaks in its membrane. Unmetabolized PMM is excreted through the lymph system in the urine of the patient.²⁷

PluroGel appears to decrease inflammation associated with a wound.²⁸ One reason for reduced inflammation, in addition to the plugging of the damaged cell membrane, may be that the bradykinins released by the damaged cells become bound in the PMM, thus limiting the severity of the inflammatory response.²⁹

A multitude of agents can be placed into the PMM. The first agents to be placed into the PMM have been antimicrobials and antiseptics. In PluroGen's first product, PluroGel PSSD, the PMM forms a barrier, while the antimicrobial prevents microbes from growing.

The Performance Functions summarize the 3 key characteristics of PluroGel that begin when PluroGel is applied to the wound. PluroGel acts as a physical barrier to cover and protect wounds and establish the optimal wound environment supportive to wound healing. PluroGel acts as a cell friendly, biocompatible¹ surfactant-based cleaner that facilitates wound cleaning and debridement. PluroGel acts as a more effective delivery system, with the PMM allowing the delivery of PluroGel and any additional active agents to more of the surface area of the wound, including the difficult to reach wound surfaces.

PluroGel is a **Multi-Function** product that is **Simple** to use, **Flexible** in its application of use, provides **Cost Savings** and improves patients' **Compliance** to follow doctors' orders which can lead to improved healing.

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