American Physical Society
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March Meeting 2023 Featured Presentations
Health and Medicine

Findings Describe How Cell Wall Development and Shape Impact Antibiotic Efficacy in Gram-Positive Bacteria like MRSA Superbug

March 6, 12:54 p.m. PST, Room 202

Gram-positive bacteria include harmful germs like those in the Staphylococcus family, which can cause strep or pneumonia. This taxonomic category is also home to Methicillin-resistant Staphylococcus aureus (MRSA) — the pathogen behind antibiotic resistant staph infections. It is thought that exploring how cell walls develop in the related rod-shaped bacterium, Bacillus subtilis, could yield useful information for optimizing therapeutics that fight MRSA. This talk by Felix Barber and colleagues will answer a 20-year-old question concerning Gram-positive bacteria's cell walls: how does one step of development, cell wall teichoic acid (WTA) synthesis, regulate cell shape? The group says their work may help explain why antibiotics that target WTA synthesis restore MRSA's susceptibility to more common treatments. They add that the results, which will also be viewable during a poster session, could also help in the creation of novel antibiotics that deliberately cause this outcome.

Spacing Matters More Than Density For B Cells in Aggressive Breast Cancer Tumors

March 7, 4:48 p.m. PST, Room 420

Tumors with more killer T cells that are closer together tend to respond better to immunotherapy treatment. This is because immunotherapy boosts T cells' ability to destroy tumor cells. But B cells, which also lurk in cancer tumors, do not kill tumor cells. Instead, they generate antibodies that train other immune cells to fight tumor cells. Until recently, whether the spatial distribution and density of B cells within tumors similarly correlates to immunotherapeutic prognosis has come under question. New work on the possible relationships between B cells' distribution, density and responsiveness to immunotherapeutics by Juliana Wortman and colleagues addresses this topic. By tracking immune cell densities and distributions in patients' tumors of particularly aggressive type of cancer called triple negative breast cancer (TNBC), the team found that TNBC tumors actually

responded better to treatments when B cells are spread farther apart. During the team's talk, this result and other findings will be contextualized, adding insights about how the spatial dynamics between intratumoral immune cells could be used to evaluate the likelihood of success for treatments like chemotherapy, radiation or even immunotherapy.

Research Explains Why Cancer Cells Can Develop Resistance to Chemotherapy After Exiting a Polyploid State
March 8, 8:12 a.m. PST, Room 308

Cancer cells that resist and survive chemotherapy do so by entering a recently described phase called the polyaneuploid cancer cell (PACC) state. But the PACC state as it relates to mechanisms that promote cancer cell survival and affect patient outcomes has not been thoroughly characterized. In this talk, Robert Austin and colleagues will discuss their new research on the elusive characteristics of the PACC state and link those characteristics to cancer cells' ability to rebound post-chemotherapy. Their analysis suggests that being in the PACC state enables surviving cancer cells to better repair DNA damaged by genotoxic chemotherapy. The group also found that the presence of additional chromosomes during PACC state facilitates the evolution of treatment-resistant mutations. They say that these results reveal two potential avenues for cancer treatment research: preventing the PACC state from emerging in cancer cells and/or stopping the PACC state from ending at which point newly resistant cancer cells begin duplicating.

Study Explains Why Some PFAS Pollutants Are Resistant To Foaming Separation
March 8, 9:12 a.m. PST, Room 127

Health-threatening chemical pollutants that last forever and accumulate in the body called per- and polyfluoroalkyl substances (PFAS) can still be found in a variety of items and resources like non-stick cookware and drinking water. Foam separation has emerged as a promising strategy to remove PFAS from water because it doesn't create additional waste products as these carcinogenic compounds migrate to the air-water interface. Yet, much is not understood about how foam fractionation works on the molecular level when it removes PFAS. More specifically, it is unclear why foam fractionation is less effective on short-chain PFAS, which have less carbon molecules. This talk by Muchu Zhou and colleagues will explore why foam fractionation success changes depending on varied-chain length PFAS. The findings, which they will also share at a poster session, could help improve short-chain PFAS removal and have implications for improving the safety of global water resources.

Magnetic Stimulation Study Shows That Brainwave Synchronization Correlates To Better Outcomes When Treating Resistant Depression
March 8, 11 a.m. PST, Exhibit Hall (Forum Ballroom)

The psychiatric field needs new ways to tackle treatment-resistant major depressive disorder (MDD), which does not respond to existing drug therapy or psychotherapy. Repetitive transcranial magnetic stimulation (rTMS) has shown some potential as a treatment for this persistent type of MDD. During this poster session, Xiaoxiao Sun and colleagues connect findings from their six week long rTMS clinical study — which used an electroencephalography (EEG)-triggered phase-locking rTMS delivery system and was active from 2018 to 2022 — to newer data regarding neuroplastic changes in participants' brainwaves. Their novel results indicate that EEG-informed rTMS neural stimulation can lead to brainwave synchronization, or entrainment. Since patients with better entrainment had greater treatment improvement, the presenters say their work spotlights the potential for EEG-informed rTMS therapy in cases of resistant MDD.

Ultrafiltration Membranes With Tunable Pores Could Improve Wastewater Reclamation
March 8, 11 a.m. PST, Exhibit Hall (Forum Ballroom)

Water scarcity is a global health concern. Experts consider wastewater reclamation one solution for addressing this issue. But which methods are best for wastewater treatment is still up for debate. In this poster session, Kshitij Sharma and colleagues unveil a methodology for better membrane filtration of wastewater, demonstrating how tuning membranes' pore sizes improves standardized filtration of nonorganic and organic waste. The technique for creating these ultrafiltration membranes could be applied in industrial and municipal settings where waste water disposal is necessary, the team says.

Together, Wearable Sensors and AI Can Detect Early Biomarkers of Heart Disease
March 8, 4:24 p.m. PST, Room 308

Early detection is important in many disorders including cardiovascular disease. Recently scientists have been exploring how artificial intelligence (AI) can be harnessed to detect heart disease and predict associated risks. Here, Anand Babu and colleagues will introduce their novel experimental approach, which synthesized wearable piezoelectric sensors with AI machine learning systems to predict the risk of cardiovascular disease in humans. Tested on 20 subjects with differing body mass indexes (BMIs) and histories of existing heart disease, the device analyzed patterns of arterial pulse to detect biomarkers of heart disease with a

prediction accuracy of over 94%. The authors stress that their design could facilitate proactive diagnosis of conditions before they progress beyond the point of recovery.

Nanoparticle-Based Technique Could Improve Treatment of Late-Stage Cancer
March 9, 11:30 a.m. PST, Room 316

Undiagnosed and untreated cancer tumors tend to metastasize — an occurrence correlated with poor treatment outcomes and high mortality rates. To target metastatic, late-stage cancers, radiation therapy applies a controlled administration of near infrared (NIR) light to tumorous tissues. This new method is called photo-immunotherapy (PIT). But this approach's efficacy depends on how well administered photons can penetrate bodily tissue. In this talk, David Beke will discuss a technique for improving radiotherapy, building upon research published from 2021 and a study from 2022. Beke and colleagues will share how nanoparticles made from chromium-doped zinc gallate spinel oxides can give off their own light emissions when exposed to X-ray or UV radiation, amplifying the number of photons that reach tumor cells during treatment. The researchers say the work, also highlighted in a poster session, demonstrates the nanoparticles' potential for in vivo bioimaging and radioactivity detection.

Scientists Present a Path for Modeling Microbes' Immune Memory
March 9, 12:06 p.m. PST, Room 238

Vaccines seek to build "immune memory" by training the immune system to mount better, faster responses upon reexposure to past pathogens. But this type of adaptive immune memory doesn't only exist in animals. Microbes also possess similar elements of immune memory. This talk, by Sidhartha Goyal and colleagues, will provide a framework for modeling the dynamics of immune memory on a microbial-scale. Using theoretical simulations and experimental CRISPR models of adaptive immunity, the team made a counterintuitive discovery: high levels of microbial diversity correlate to low overall immune memory. In addition to this finding, other results related to the evolution of coexisting bacteria and phage diversity could enhance knowledge about microbial communities and how manipulating their immunity can advance public health.

Experiment Shares More Results on New Device that Monitors the Heart's Electrical Activity Without Temperature Constraints
March 9, 1 p.m. PST, Exhibit Hall (Forum Ballroom)

According to 2022 data from the Centers for Disease Control and Prevention, someone in the United States experiences a heart attack every 40 seconds. One way to monitor heart health is through magnetocardiography, in which superconductive quantum interference devices (SQUIDs) detect and measure magnetic fields produced by the heart's electrical activity. Currently, SQUIDs best operate at -269 degrees Celsius — a temperature which is difficult to reach outside of a high caliber, state-of-the-art laboratory. During this poster session, Alexander Khitun will share new experimental data on a magnetic sensor that was recently published in 2020 and which may have the same sensitivity as SQUIDs and easily functions at room temperature. Based on spin wave interferometer technology described in 2017, the compact device goes on a patient's chest to obtain data and can upload that data to the patient's doctor or their healthcare center's electronic records. The technique could also be used to proactively warn patients about upcoming heart attacks.