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Titan Pharmaceuticals and Walter Reed Army Institute of Research Collaborate to Evaluate ProNeura Antimalarial Implants

Initial non-clinical studies with ProNeura implants incorporating antimalarial drugs demonstrate proof-of-concept

SOUTH SAN FRANCISCO, Calif., July 6, 2017 /PRNewswire/ --Titan Pharmaceuticals, Inc. (NASDAQ: TTNP), a specialty pharmaceutical company developing proprietary therapeutics for the treatment of select chronic diseases utilizing its ProNeura™ long-term, continuous drug delivery technology, announced today that it has entered into a Cooperative Research and Development Agreement (CRADA) with Walter Reed Army Institute of Research (WRAIR) and Southwest Research Institute (SwRI) to evaluate the development of ProNeura-based implants for a long-term regimen in the prevention of malaria.

"The Walter Reed Army Institute of Research has been involved with testing virtually every drug approved by the U.S. Food and Drug Administration for protection against malaria, and we are excited to be collaborating with the organization on this important endeavor," said Titan President and CEO Sunil Bhonsle. "ProNeura's ability to provide long-term, continuous drug delivery could represent an important advance over current approved daily dosed antimalarial products."

Initial non-clinical studies have demonstrated preliminary proof-of-concept and the results were recently presented by the Experimental Therapeutics (ET) branch of WRAIR at the 2017 Asia Pacific Military Health Exchange (APMHE) in Singapore. ProNeura implants containing piperaquine, an effective compound against blood stage parasites, were formulated at SwRI and tested at WRAIR in a mouse model infected with *Plasmodium berghei*, to characterize the pharmacokinetic (PK) release profile and long-term prophylactic efficacy. Piperaquine implants demonstrated sustained drug release for 6 weeks of PK analysis, and exhibited sufficient suppression of early blood stage malaria in infected mice, as assessed by IVIS (*In Vivo* Imaging System). Furthermore, complete protection from infection with *Plasmodium berghei* parasites was demonstrated for up to 8 weeks post-

implantation in mice. In addition, the sustained release of other antimalarial drugs, atovaquone and doxycycline, were demonstrated *in vivo* with their respective ProNeura-based implants.

There is an important need for a reliable long-term regimen for the prevention of malaria in resource-constrained environments. The development of long-acting implants could greatly improve compliance with a reliable treatment regimen, potentially allowing ground combat forces to maneuver and perform in an uninterrupted manner. The preliminary findings of the study allow WRAIR to pursue additional studies with long-acting ProNeura implants that include FDA-approved anti-malarial drugs.

"We look forward to a constructive research collaboration with Titan Pharmaceuticals and Southwest Research Institute on sustained-release antimalarial implants," said Lt. Col. Mara Kreishman-Deitrick, PhD, director of ET at WRAIR.

About Titan Pharmaceuticals
Titan Pharmaceuticals Inc. (NASDAQ: TTNP), based in South San Francisco, CA, is developing proprietary therapeutics primarily for the treatment of serious medical disorders. The company's lead product is Probuphine®, a novel and long-acting formulation of buprenorphine for the long-term maintenance treatment of opioid dependence. Probuphine employs Titan's proprietary drug delivery system ProNeura™, which is capable of delivering sustained, consistent levels of medication for three months or longer. Titan has granted commercial rights in the U.S. and Canada for Probuphine to Braeburn Pharmaceuticals. Approved by the U.S. Food and Drug Administration in May 2016, Probuphine is the first and only commercialized treatment of opioid dependence to provide continuous, around-the-clock blood levels of buprenorphine for six months following a single procedure. The ProNeura technology has the potential to be used in developing products for treating other chronic conditions such as Parkinson's disease and hypothyroidism, where maintaining consistent, around-the-clock blood levels of medication may benefit the patient and improve medical outcomes. For more information about Titan, please visit www.titanpharm.com.

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CONTACT:

Titan Pharmaceuticals, Inc.:
Sunil Bhonsle, President

(650) 244-4990

Investors:
Stephen Kilmer
(650) 989-2215
skilmer@titanpharm.com

Media:
Susan Thomas
(650) 989-2216
sthomas@titanpharm.com

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