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<b>(21) International Application Number:</b> PCT/US98/13272 <b>(22) International Filing Date:</b> 26 June 1998 (26.06.98)  <b>(30) Priority Data:</b> 60/051,021 27 June 1997 (27.06.97) US 08/926,155 9 September 1997 (09.09.97) US  <b>(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Applications</b> US 60/051,021 (CIP) Filed on 27 June 1997 (27.06.97) US 08/926,155 (CIP) Filed on 9 September 1997 (09.09.97)  <b>(71) Applicant (for all designated States except US):</b> VIVORX PHARMACEUTICALS, INC. [US/US]; 2825 Santa Monica Boulevard, Santa Monica, CA 90404 (US).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> DESAI, Neil, P. [IN/US]; 3633 Purdue Avenue, Los Angeles, CA 90066 (US). SOON-SHIONG, Patrick [US/US]; 11755 Chenault Street, Los Angeles, CA 90049 (US). MAGDASSI, Shlomo [IL/IL]; Hanerd Street 36, Jerusalem (IL). SAHADEVAN,	David, C. [US/US]; 13626 Franklin Street #3, Whittier, CA 90602 (US).  <b>(74) Agent:</b> RAYMER, Gregory, P.; Gray Cary Ware & Freidenrich, Suite 1600, 4365 Executive Drive, San Diego, CA 92121 (US).  <b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>	
<b>(54) Title:</b> NOVEL FORMULATIONS OF PHARMACOLOGICAL AGENTS, METHODS FOR THE PREPARATION THEREOF AND METHODS FOR THE USE THEREOF		
<b>(57) Abstract</b>  <p>In accordance with the present invention, there are provided compositions and methods useful for the <i>in vivo</i> delivery of substantially water insoluble pharmacologically active agents (such as the anticancer drug paclitaxel) in which the pharmacologically active agent is delivered in the form of suspended particles coated with protein (which acts as a stabilizing agent). In particular, protein and pharmacologically active agent in a biocompatible dispersing medium are subjected to high shear, in the absence of any conventional surfactants, and also in the absence of any polymeric core material for the particles. The procedure yields particles with a diameter of less than about 1 micron. The use of specific composition and preparation conditions (e.g., addition of a polar solvent to the organic phase), and careful selection of the proper organic phase and phase fraction, enables the reproducible production of unusually small nanoparticles of less than 200 nm diameter, which can be sterile-filtered. The particulate system produced according to the invention can be converted into a redispersible dry powder comprising nanoparticles of water-insoluble drug coated with a protein, and free protein to which molecules of the pharmacological agent are bound. This results in a unique delivery system, in which part of the pharmacologically active agent is readily bioavailable (in the form of molecules bound to the protein), and part of the agent is present within particles without any polymeric matrix therein.</p>		

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NOVEL FORMULATIONS OF PHARMACOLOGICAL AGENTS,  
METHODS FOR THE PREPARATION THEREOF AND  
METHODS FOR THE USE THEREOF

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FIELD OF THE INVENTION

The present invention relates to methods for the production of particulate vehicles for the intravenous administration of pharmacologically active agents, as well as novel compositions produced thereby. In a particular aspect, 10 the invention relates to methods for the *in vivo* delivery of substantially water insoluble pharmacologically active agents (e.g., the anticancer drug Taxol®). In another aspect, dispersible colloidal systems containing water insoluble pharmacologically active agents are provided. The suspended 15 particles may be formed of 100% active agent, or may be encased in a polymeric shell formulated from a biocompatible polymer, and have a diameter of less than about 1 micron. Invention colloidal systems may be prepared without the use of conventional surfactant or any polymeric core matrix. In a 20 presently preferred aspect of the invention, there is provided a method for preparation of extremely small particles which can be sterile-filtered. The polymeric shell contains particles of pharmacologically active agent, and optionally a biocompatible dispersing agent in which pharmacologically active agent can be 25 either dissolved or suspended. Thus, the invention provides a drug delivery system in either liquid form or in the form of a redispersible powder. Either form provides both immediately bioavailable drug molecules (i.e., drug molecules which are molecularly bound to a protein), and pure drug particles coated 30 with a protein.

### FIELD OF THE INVENTION

The invention also relates to the method of use and  
5 preparation of compositions (formulations) of drugs such as the  
anticancer agent paclitaxel. In one aspect, the formulation of  
paclitaxel, known as Capxol, is significantly less toxic and  
more efficacious than Taxol<sup>®</sup>, a commercially available  
formulation of paclitaxel. In another aspect, the novel  
10 formulation Capxol, localizes in certain tissues after  
parenteral administration thereby increasing the efficacy of  
treatment of cancers associated with such tissues.

### BACKGROUND OF THE INVENTION

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Intravenous drug delivery permits rapid and direct  
equilibration with the blood stream which carries the  
medication to the rest of the body. To avoid the peak serum  
levels which are achieved within a short time after  
20 intravascular injection, administration of drugs carried within  
stable carriers would allow gradual release of the drugs inside  
the intravascular compartment following a bolus intravenous  
injection of the therapeutic nanoparticles.

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Injectable controlled-release nanoparticles can  
provide a pre-programmed duration of action, ranging from days  
to weeks to months from a single injection. They also can  
offer several profound advantages over conventionally  
administered medicaments, including automatic assured patient  
30 compliance with the dose regimen, as well as drug targeting to  
specific tissues or organs (Tice and Gilley, *Journal of  
Controlled Release* 2:343-352 (1985)).

Microparticles and foreign bodies present in the blood are generally cleared from the circulation by the "blood filtering organs", namely the spleen, lungs and liver. The particulate matter contained in normal whole blood comprises red blood cells (typically 8 microns in diameter), white blood cells (typically 6-8 microns in diameter), and platelets (typically 1-3 microns in diameter). The microcirculation in most organs and tissues allows the free passage of these blood cells. When microthrombi (blood clots) of size greater than 10-15 microns are present in circulation, a risk of infarction or blockage of the capillaries results, leading to ischemia or oxygen deprivation and possible tissue death. Injection into the circulation of particles greater than 10-15 microns in diameter, therefore, must be avoided. A suspension of particles less than 7-8 microns, is however, relatively safe and has been used for the delivery of pharmacologically active agents in the form of liposomes and emulsions, nutritional agents, and contrast media for imaging applications.

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The size of particles and their mode of delivery determines their biological behavior. Strand et al. (in *Microspheres-Biomedical Applications*, ed. A. Rembaum, pp 193-227, CRC Press (1988)) have described the fate of particles to be dependent on their size. Particles in the size range of a few nanometers (nm) to 100 nm enter the lymphatic capillaries following interstitial injection, and phagocytosis may occur within the lymph nodes. After intravenous/intraarterial injection, particles less than about 2 microns will be rapidly cleared from the blood stream by the reticuloendothelial system (RES), also known as the mononuclear phagocyte system (MPS).

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