



Supplementary Materials: Effect of Poly(L-lysine) and Heparin Coatings on the Surface of Polyester-Based Particles on Prednisolone Release and Biocompatibility

Abdelrahman Mohamed ^{1,2}, Viktor Korzhikov-Vlakh ^{1,*}, Nan Zhang ³, André Said ³, Julia Pilipenko ¹, Monika Schäfer-Korting ³, Christian Zoschke ^{3,4} and Tatiana Tennikova ¹

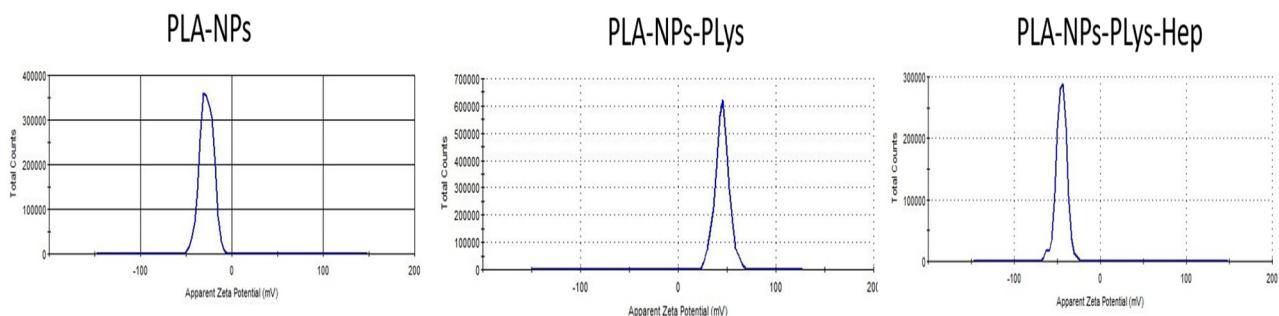


Figure S1. ζ -potential diagrams obtained by ELS (Zetasizer Nano ZS, Malvern) for non-modified and modified PLA NPs.

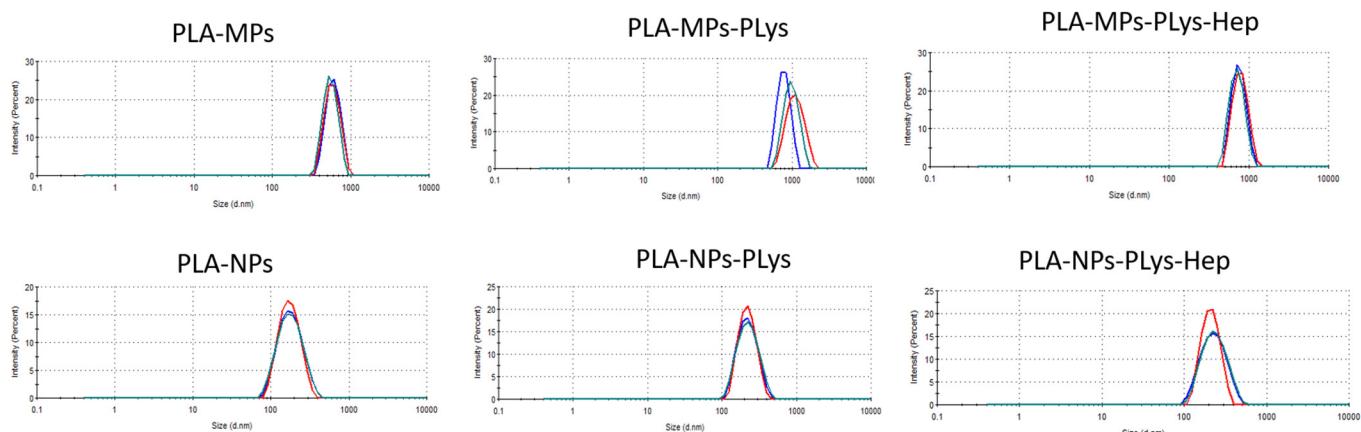


Figure S2. Size distribution diagrams obtained by DLS (Zetasizer Nano ZS, Malvern) for non-modified and modified PLA MPs and NPs.

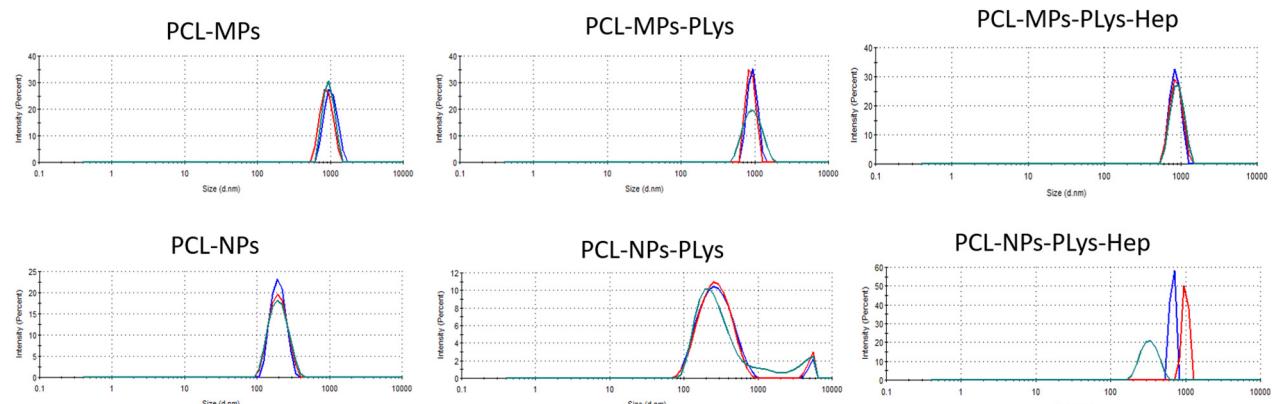


Figure S3. Size distribution diagrams obtained by DLS (Zetasizer Nano ZS, Malvern) for non-modified and modified PCL MPs and NPs.

Table S1. Correlation coefficients and constants evaluated by fitting prednisolone release from PLA MPSs.

Model	PLA MPs		PLA MPs-PLys		PLA MPs-PLys-Hep		PLA MPs-(PLys-Hep) ₂	
	6 h	720 h						
<i>Zero-order</i>	R ² = 0.8707	R ² = 0.7123	R ² = 0.7769	R ² = 0.6929	R ² = 0.7786	R ² = 0.7723	R² = 0.9839	R ² = 0.9581
<i>F = K_o*t</i>	K _o = 11.561	K _o = 0.162	K _o = 6.194	K _o = 0.096	K _o = 5.182	K _o = 0.074	K _o = 1.792	K _o = 0.052
<i>First-order</i>								
<i>F = 100*[1-Exp(-K₁*t)]</i>	R ² = 0.9396	R ² = 0.9256	R ² = 0.8114	R ² = 0.7603	R ² = 0.8063	R ² = 0.7964	R² = 0.9867	R ² = 0.9647
<i>Higuchi</i>	R ² = 0.9774	R ² = 0.8349	R ² = 0.9360	R ² = 0.8385	R ² = 0.9375	R ² = 0.8638	R² = 0.9816	R ² = 0.9729
<i>F = K_H*t^{0.5}</i>	K _H = 24.837	K _H = 4.366	K _H = 13.741	K _H = 2.623	K _H = 11.492	K _H = 1.954	K _H = 3.588	K _H = 1.221
<i>Korsmeyer-Peppas</i>	R ² = 0.9869	R ² = 0.9690	R ² = 0.9973	R ² = 0.9892	R ² = 0.9971	R ² = 0.9835	R ² = 0.9973	R ² = 0.9678
<i>F = K_{kp}*tⁿ</i>	K _{kp} = 28.327	K _{kp} = 34.072	K _{kp} = 18.620	K _{kp} = 20.814	K _{kp} = 15.504	K _{kp} = 16.152	K _{kp} = 2.678	K _{kp} = 2.141
<i>Hixon-Crowell</i>	R ² = 0.9468	R ² = 0.8161	R ² = 0.7999	R ² = 0.7351	R ² = 0.7970	R ² = 0.7886	R² = 0.9858	R ² = 0.9629
<i>F=100*[1-(1-K_{HC}*t)³]</i>	K _{HC} = 0.077	K _{HC} = 1.9*10 ⁻³	K _{HC} = 0.024	K _{HC} = 4.9*10 ⁻⁴	K _{HC} = 0.020	K _{HC} = 3.3*10 ⁻⁴	K _{HC} = 0.006	K _{HC} = 2.0*10 ⁻⁴
<i>Hopfenberg</i>	R ² = 0.9396	R ² = 0.9258	R ² = 0.8114	R ² = 0.7603	R ² = 0.8063	R ² = 0.7964	R² = 0.9867	R ² = 0.9647
<i>F=100*[1-(1-K_{Hb}*t)ⁿ]</i>	K _{Hb} = 9.1*10 ⁻⁵	K _{Hb} = 6.8*10 ⁻⁵	K _{Hb} = 6.2*10 ⁻⁵	K _{Hb} = 7.3*10 ⁻⁷	K _{Hb} = 6.3*10 ⁻⁵	K _{Hb} = 1.4*10 ⁻⁶	K _{Hb} = 1.1*10 ⁻⁴	K _{Hb} = 1.4*10 ⁻⁶
<i>Baker-Lonsdale</i>								
<i>3/2*[1-(1-F/100)^{2/3}]-F/100=K_{BL}*t</i>	R ² = 0.9866	R ² = 0.8795	R ² = 0.9455	R ² = 0.8636	R ² = 0.9450	R ² = 0.8712	R² = 0.9815	R ² = 0.9707
<i>Weibull</i>	R ² = 0.9950	R ² = 0.9844	R ² = 0.9984	R ² = 0.9963	R ² = 0.9997	R ² = 0.9847	R ² = 0.9992	R ² = 0.9701
<i>F=100*[1-Exp[-((t-Ti)β)/α]]</i>	α = 2.462	α = 2.173	α = 4.483	α = 4.061	α = 5.278	α = 5.312	α = 29.940	α = 210.796
<i>Peppas-Sahlin</i>	R ² = 0.9996	R ² = 0.9723	R ² = 0.9993	R ² = 0.9980	R ² = 0.9999	R ² = 0.9838	R ² = 0.9994	R ² = 0.9731
<i>F=K₁*t^m+K₂*t²</i>	K ₁ = 32.2	K ₁ = 36.4	K ₁ = 23.7	K ₁ = 21.6	K ₁ = 19.8	K ₁ = 13.2	K ₁ = 6.1	K ₁ = 2.1
<i>*m)</i>	K ₂ = 4.8	K ₂ = 3.7	K ₂ = 5.0	K ₂ = 2.3	K ₂ = 4.2	K ₂ = 3.1	K ₂ = 8.7	K ₂ = 0.3

Table S2. Correlation coefficients and constants evaluated by fitting prednisolone release from PLA NPs.

Model	PLA NPs		PLA NPs-PLys		PLA NPs-PLys-Hep		PLA NPs-(PLys-Hep) ₂	
	6 h	720 h						
<i>Zero-order</i>	R ² = 0.8801	R ² = 0.6468	R ² = 0.8552	R ² = 0.6729	R ² = 0.8222	R ² = 0.7028	R ² = 0.9414	R ² = 0.8389
<i>F = K_o*t</i>	K _o = 14.1	K _o = 0.18	K _o = 8.36	K _o = 0.11	K _o = 7.21	K _o = 0.08	K _o = 2.76	K _o = 0.06
<i>First-order</i>								
<i>F = 100*[1-Exp(-K₁*t)]</i>	R ² = 0.9662	R ² = 0.9597	R ² = 0.8981	R ² = 0.7325	R ² = 0.8618	R ² = 0.7247	R ² = 0.9494	R ² = 0.8599
<i>Higuchi</i>	R ² = 0.9738	R ² = 0.7891	R ² = 0.9758	R ² = 0.7970	R ² = 0.9598	R ² = 0.7803	R² = 0.9985	R ² = 0.9352
<i>F = K_H*t^{0.5}</i>	K _H = 30.023	K _H = 5.055	K _H = 18.129	K _H = 2.864	K _H = 15.797	K _H = 2.240	K _H = 5.766	K _H = 1.628
<i>Korsmeyer-Peppas</i>	R ² = 0.9775	R ² = 0.9539	R ² = 0.9973	R ² = 0.9749	R ² = 0.9940	R ² = 0.9466	R² = 0.9985	R² = 0.9846
<i>F = K_{kp}*tⁿ</i>	K _{kp} = 32.403	K _{kp} = 41.424	K _{kp} = 22.125	K _{kp} = 25.645	K _{kp} = 20.089	K _{kp} = 21.692	K _{kp} = 5.759	K _{kp} = 7.666
<i>Hixon-Crowell</i>	R ² = 0.9468	R ² = 0.7793	R ² = 0.8843	R ² = 0.7119	R ² = 0.8487	R ² = 0.7180	R ² = 0.9468	R ² = 0.8530
<i>F=100*[1-(1-K_{HC}*t)³]</i>	K _{HC} = 0.08	K _{HC} = 2.1*10 ⁻³	K _{HC} = 0.04	K _{HC} = 6.0*10 ⁻⁴	K _{HC} = 0.03	K _{HC} = 3.9*10 ⁻⁴	K _{HC} = 0.01	K _{HC} = 2.6*10 ⁻⁴
<i>Hopfenberg</i>	R ² = 0.9659	R ² = 0.9598	R ² = 0.8980	R ² = 0.7324	R ² = 0.8617	R ² = 0.7246	R ² = 0.9493	R ² = 0.8599
<i>F=100*[1-(1-K_{Hb}*t)ⁿ]</i>	K _{Hb} = 6.2*10 ⁻⁴	K _{Hb} = 1.4*10 ⁻⁴	K _{Hb} = 1.1*10 ⁻⁴	K _{Hb} = 1.1*10 ⁻⁶	K _{Hb} = 8.3*10 ⁻⁵	K _{Hb} = 1.9*10 ⁻⁶	K _{Hb} = 3.3*10 ⁻⁴	K _{Hb} = 1.6*10 ⁻⁶
<i>Baker-Lonsdale</i>								
<i>3/2*[1-(1-F/100)^{2/3}]-F/100=K_{BL}*t</i>	R ² = 0.9819	R ² = 0.8488	R ² = 0.9839	R ² = 0.8206	R ² = 0.9687	R ² = 0.7874	R² = 0.9987	R ² = 0.9414
<i>Weibull</i>	R ² = 0.9956	R ² = 0.9898	R ² = 0.9991	R ² = 0.9893	R ² = 0.9961	R ² = 0.9546	R ² = 0.9997	R ² = 0.9895

$F=100 \cdot \{1 - Exp[-((t - Ti)^{\beta})/\alpha]\}$	$\alpha = 1.87$	$\alpha = 1.67$	$\alpha = 3.60$	$\alpha = 3.06$	$\alpha = 4.03$	$\alpha = 3.73$	$\alpha = 5.28$	$\alpha = 11.52$
$F=K_1 \cdot t^m + K_2 \cdot t^{l/2}$	$\beta = 0.44$	$\beta = 0.24$	$\beta = 0.33$	$\beta = 0.14$	$\beta = 0.28$	$\beta = 0.11$	$\beta = 0.19$	$\beta = 0.24$
<i>Peppas-Sahlén</i>	$R^2 = 0.9970$	$R^2 = 0.9671$	$R^2 = 0.9998$	$R^2 = 0.9787$	$R^2 = 0.9981$	$R^2 = 0.9754$	$R^2 = 0.9998$	$R^2 = 0.9852$
$F=K_1 \cdot t^m + K_2 \cdot t^{l/2}$	$K_1 = 35.2$	$K_1 = 43.3$	$K_1 = 26.4$	$K_1 = 28.3$	$K_1 = 24.7$	$K_1 = 18.3$	$K_1 = 6.3$	$K_1 = 7.7$
$*_{m/}$	$K_2 = 4.6$	$K_2 = 4.9$	$K_2 = 4.3$	$K_2 = 3.6$	$K_2 = 4.6$	$K_2 = 1.9$	$K_2 = 0.6$	$K_2 = 0.3$

Table S3. Correlation coefficients and constants evaluated by fitting prednisolone release from PCL MPS.

Model	PCL MPs		PCL MPs-PLys		PCL MPs-PLys-Hep		PCL MPs-(PLys-Hep) ₂	
	6 h	720 h						
<i>Zero-order</i>	$R^2 = 0.8802$	$R^2 = 0.7607$	$R^2 = 0.9622$	$R^2 = 0.7613$	$R^2 = 0.9251$	$R^2 = 0.8788$	$R^2 = 0.9894$	$R^2 = 0.9286$
$F = K_0 \cdot t$	$K_0 = 10.6$	$K_0 = 0.16$	$K_0 = 4.30$	$K_0 = 0.08$	$K_0 = 2.80$	$K_0 = 0.06$	$K_0 = 0.66$	$K_0 = 0.04$
<i>First-order</i>								
$F = 100 \cdot \{1 - Exp(-K_1 \cdot t)\}$	$R^2 = 0.9336$	$R^2 = 0.9029$	$R^2 = 0.9731$	$R^2 = 0.8044$	$R^2 = 0.9346$	$R^2 = 0.8980$	$R^2 = 0.9897$	$R^2 = 0.9413$
$Higuchi$	$R^2 = 0.9690$	$R^2 = 0.8694$	$R^2 = 0.9844$	$R^2 = 0.8894$	$R^2 = 0.9867$	$R^2 = 0.9516$	$R^2 = 0.9731$	$R^2 = 0.9931$
$F = K_H \cdot t^{0.5}$	$K_H = 22.6$	$K_H = 4.3$	$K_H = 8.8$	$K_H = 2.1$	$K_H = 5.8$	$K_H = 1.5$	$K_H = 1.3$	$K_H = 1.0$
<i>Korsmeyer-Peppas</i>	$R^2 = 0.9716$	$R^2 = 0.9671$	$R^2 = 0.9907$	$R^2 = 0.9719$	$R^2 = 0.9866$	$R^2 = 0.9784$	$R^2 = 0.9973$	$R^2 = 0.9940$
$F = K_{KP} \cdot t^n$	$K_{KP} = 24.17$	$K_{KP} = 29.6$	$K_{KP} = 7.3$	$K_{KP} = 11.4$	$K_{KP} = 5.8$	$K_{KP} = 6.6$	$K_{KP} = 1.6$	$K_{KP} = 1.0$
<i>Hixon-Crowell</i>								
$F = 100 \cdot \{1 - (1 - K_{HC} \cdot t)^3\}$	$R^2 = 0.9176$	$R^2 = 0.8463$	$R^2 = 0.9696$	$R^2 = 0.7898$	$R^2 = 0.9315$	$R^2 = 0.8920$	$R^2 = 0.9896$	$R^2 = 0.9372$
$F = 100 \cdot \{1 - (1 - K_{HB} \cdot t)^3\}$	$K_{HC} = 0.05$	$K_{HC} = 1.9 \cdot 10^{-3}$	$K_{HC} = 0.02$	$K_{HC} = 3.6 \cdot 10^{-4}$	$K_{HC} = 0.01$	$K_{HC} = 2.4 \cdot 10^{-4}$	$K_{HC} = 2.2 \cdot 10^{-3}$	$K_{HC} = 1.5 \cdot 10^{-4}$
<i>Hopfenberg</i>								
$F = 100 \cdot \{1 - (1 - K_{HB} \cdot t)^n\}$	$R^2 = 0.9335$	$R^2 = 0.9027$	$R^2 = 0.9731$	$R^2 = 0.8043$	$R^2 = 0.9346$	$R^2 = 0.8979$	$R^2 = 0.9897$	$R^2 = 0.9413$
$F = K_{Hfb} \cdot t^{1/2}$	$K_{Hfb} = 8.1 \cdot 10^{-5}$	$K_{Hfb} = 3.5 \cdot 10^{-5}$	$K_{Hfb} = 7.0 \cdot 10^{-5}$	$K_{Hfb} = 9.9 \cdot 10^{-7}$	$K_{Hfb} = 7.6 \cdot 10^{-5}$	$K_{Hfb} = 3.3 \cdot 10^{-6}$	$K_{Hfb} = 1.3 \cdot 10^{-4}$	$K_{Hfb} = 6.1 \cdot 10^{-7}$
<i>Baker-Lonsdale</i>								
$3/2 \cdot \{1 - (1 - F/100)^{(2/3)}\} \cdot J$	$R^2 = 0.9742$	$R^2 = 0.9031$	$R^2 = 0.9830$	$R^2 = 0.9036$	$R^2 = 0.9871$	$R^2 = 0.9547$	$R^2 = 0.9751$	$R^2 = 0.9944$
$F/100 = K_{BL} \cdot t$	$K_{BL} = 0.01$	$K_{BL} = 6.9 \cdot 10^{-4}$	$K_{BL} = 1.4 \cdot 10^{-3}$	$K_{BL} = 9.8 \cdot 10^{-5}$	$K_{BL} = 5.9 \cdot 10^{-4}$	$K_{BL} = 4.6 \cdot 10^{-5}$	$K_{BL} = 2.9 \cdot 10^{-5}$	$K_{BL} = 1.7 \cdot 10^{-5}$
<i>Weibull</i>								
$F = 100 \cdot \{1 - Exp[-((t - Ti)^{\beta})/\alpha]\}$	$R^2 = 0.9991$	$R^2 = 0.9847$	$R^2 = 0.9972$	$R^2 = 0.9938$	$R^2 = 0.9896$	$R^2 = 0.9781$	$R^2 = 0.9938$	$R^2 = 0.9979$
$\alpha = 2.483$	$\alpha = 2.457$	$\alpha = 10.086$	$\alpha = 6.435$	$\alpha = 14.405$	$\alpha = 13.602$	$\alpha = 105.811$	$\alpha = 62.802$	
$\beta = 0.321$	$\beta = 0.223$	$\beta = 0.555$	$\beta = 0.196$	$\beta = 0.448$	$\beta = 0.256$	$\beta = 0.771$	$\beta = 0.435$	
<i>Peppas-Sahlén</i>	$R^2 = 0.9844$	$R^2 = 0.9681$	$R^2 = 0.9979$	$R^2 = 0.9798$	$R^2 = 0.9960$	$R^2 = 0.9794$	$R^2 = 0.9957$	$R^2 = 0.9976$
$F = K_1 \cdot t^m + K_2 \cdot t^{l/2}$	$K_1 = 27.063$	$K_1 = 30.978$	$K_1 = 53.486$	$K_1 = 10.921$	$K_1 = 6.038$	$K_1 = 5.899$	$K_1 = 0.750$	$K_1 = 1.430$
$*_{m/}$	$K_2 = 3.613$	$K_2 = 2.131$	$K_2 = 60.640$	$K_2 = 0.704$	$K_2 = 0.668$	$K_2 = 0.915$	$K_2 = 0.224$	$K_2 = 0.013$

Table S4. Correlation coefficients and constants evaluated by fitting prednisolone release from PCL NPs.

Model	PCL NPs		PCL NPs-PLys		PCL NPs-PLys-Hep		PCL NPs-(PLys-Hep) ₂	
	6 h	720 h						
<i>Zero-order</i>	R ² = 0.9259	R ² = 0.7216	R ² = 0.9682	R ² = 0.7319	R ² = 0.9258	R ² = 0.8016	R ² = 0.9373	R ² = 0.9040
<i>F = K₀*t</i>	K ₀ = 11.59	K ₀ = 0.18	K ₀ = 5.27	K ₀ = 0.10	K ₀ = 3.42	K ₀ = 0.07	K ₀ = 1.16	K ₀ = 0.05
<i>First-order</i>								
<i>F = 100*[1-Exp(-K₁*t)]</i>	R ² = 0.9726	R ² = 0.9480	R ² = 0.9801	R ² = 0.8023	R ² = 0.9378	R ² = 0.8323	R ² = 0.9409	R ² = 0.9209
<i>Higuchi</i>	R ² = 0.9918	R ² = 0.8550	R ² = 0.9904	R ² = 0.8731	R ² = 0.9898	R ² = 0.9162	R ² = 0.9913	R ² = 0.9828
<i>F = K_H*t^{0.5}</i>	K _H = 24.3	K _H = 4.8	K _H = 10.7	K _H = 2.6	K _H = 7.2	K _H = 1.8	K _H = 2.4	K _H = 1.2
<i>Korsmeyer-Peppas</i>	R ² = 0.9919	R ² = 0.9702	R ² = 0.9961	R ² = 0.9685	R ² = 0.9898	R ² = 0.9855	R ² = 0.9914	R ² = 0.9964
<i>F = K_{KP}*tⁿ</i>	K _{KP} = 24.5	K _{KP} = 32.8	K _{KP} = 9.1	K _{KP} = 14.9	K _{KP} = 7.1	K _{KP} = 9.5	K _{KP} = 2.3	K _{KP} = 3.0
<i>Hixon-Crowell</i>	R ² = 0.9600	R ² = 0.8465	R ² = 0.9765	R ² = 0.07781	R ² = 0.9339	R ² = 0.8221	R ² = 0.9397	R ² = 0.9154
<i>F=100*[1-(1-K_{HC}*t)³]</i>	K _{HC} = 0.05	K _{HC} = 2.1*10 ⁻³	K _{HC} = 0.02	K _{HC} = 5.2*10 ⁻⁴	K _{HC} = 0.01	K _{HC} = 2.9*10 ⁻⁴	K _{HC} = 4.0*10 ⁻³	K _{HC} = 1.8*10 ⁻⁴
<i>Hopfenberg</i>	R ² = 0.9726	R ² = 0.9027	R ² = 0.9801	R ² = 0.8022	R ² = 0.9378	R ² = 0.8322	R ² = 0.9897	R ² = 0.9208
<i>F=100*[1-(1-K_{Hb}*t)ⁿ]</i>	K _{Hb} = 3.7*10 ⁻⁵	K _{Hb} = 3.5*10 ⁻⁵	K _{Hb} = 4.6*10 ⁻⁵	K _{Hb} = 2.7*10 ⁻⁷	K _{Hb} = 4.6*10 ⁻⁵	K _{Hb} = 2.6*10 ⁻⁶	K _{Hb} = 1.3*10 ⁻⁴	K _{Hb} = 3.5*10 ⁻⁶
<i>Baker-Lonsdale</i>								
<i>3/2*[1-(1-F/100)^{(2/3)}]-F/100=K_{BL}*t</i>	R ² = 0.9927	R ² = 0.9061	R ² = 0.9884	R ² = 0.8963	R ² = 0.9904	R ² = 0.9257	R ² = 0.9918	R ² = 0.9855
<i>Weibull</i>	R ² = 0.9999	R ² = 0.9912	R ² = 0.9999	R ² = 0.9893	R ² = 0.9985	R ² = 0.9959	R ² = 0.9976	R ² = 0.9972
<i>F=100*[1-Exp[-((t-Ti)^β)/α]]</i>	α = 2.740	α = 2.336	α = 8.267	α = 5.606	α = 10.527	α = 8.986	α = 33.780	α = 32.202
<i>Peppas-Sahlin</i>	R ² = 0.9976	R ² = 0.9781	R ² = 0.9998	R ² = 0.9836	R ² = 0.9992	R ² = 0.9882	R ² = 0.9999	R ² = 0.9965
<i>F=K₁*t^m+K₂*t²</i>	K ₁ = 26.808	K ₁ = 33.189	K ₁ = 39.805	K ₁ = 13.738	K ₁ = 7.561	K ₁ = 9.425	K ₁ = 2.430	K ₁ = 2.865
<i>*m)</i>	K ₂ = 3.094	K ₂ = 2.905	K ₂ = 48.796	K ₂ = 0.915	K ₂ = 0.851	K ₂ = 0.543	K ₂ = 0.254	K ₂ = 0.033

Approximation of prednisolone release data are available at google drive:

<https://drive.google.com/drive/folders/1Rre1REwvMYzEUpFPx2DOC9CE3JS0Tp2N?usp=sharing>