Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2018					

PHA310 – Clinical Pharmacokinetics	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has 2 Sections (A and B):
Section A contains Forty (40) Multiple Choice Questions. Answer all questions on the College supplied Multiple Choice Answer Sheet. Total marks allocated: Forty (40). Suggested time allocation: One hour (60 minutes).

Section B contains Six (6) Calculation Questions. Answer all questions in the 20-page Booklet provided. Show all relevant steps in your calculations and include all relevant units in your answers. Total marks allocated: One hundred (100). Suggested time allocation: Two hours (120) minutes.

Total marks for this exam paper: 140

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x 5-Multiple Choice Answer Sheet 1 x Scrap Paper Formula Sheet/s Graph Papers

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Section A

Section B

Calculation Questions

Total Marks for this section: 100

Answer ALL Six (6) questions

This section should be answered in the 20-page Answer Booklet provided.
Marks for each question are indicated.
Show all relevant steps in your calculations and include all relevant units in your answers.
Suggested Time allocation for Section B: 120 min

Question 1 (16 marks; Suggested time allocation 20 min)

After 400mg of an antibiotic was administered intravenously as a single dose to Mrs L a plot of the plasma drug concentration-time profile on a semilog paper is linear with slope of -0.1 h^{-1} and y-intercept of 1 μg/ml.

a Calculate k, Vd, CL_T, AUC and $t_{½}$ of this antibiotic in Mrs L.

(8 marks)

b What are the slope and y-intercept if the dose was 800 mg?

(2 marks)

c Calculate the time required for the initial drug concentration to reduce to 0.25 μg/ml after IV administration of the 400 mg dose.

(3 marks)

d What is the minimum dose required to achieve plasma drug concentration above 1 μg/ml for 6 hours after drug administration?

(3 marks)

Question 2 (10 marks; Suggested time allocation 12 min)

Ms KY, a 60-year old, 60 kg female is admitted to the hospital due to acute pneumonia. She is receiving 75 mg gentamicin as repeated IV infusions (for 1 hour) every 12 hours. Her serum creatinine is found to be 2.5 mg/dL. Assuming the clearance of the antibiotic is 7.2L/hr with an elimination half-life ($t_{½}$) of 3 hours:

a Estimate the creatinine clearance in this patient.

(2 marks)

b Calculate the plasma concentration of the antibiotic in Ms KY after the first IV infusion.

(2 marks)

c Calculate C_{max}, C_{min} and $C_{average}$ of this antibiotic in Ms KY at steady-state.

(6 marks)

Question 3 (16 marks; Suggested time allocation 20 min)

After a single IV bolus administration of 10mg of a drug, the following plasma concentrations were obtained. The *terminal rate constant* for the decline in drug concentration (λ) is $0.1h^{-1.}$ Calculate the *MRT*, clearance and Vd_{ss}.

Time (hr)	Concentration (µg/L)
0	500
1	390
3	240
6	120
9	68
12	41
18	18
24	9.4

Question 4 (20 marks; Suggested time allocation 22 min)

After an IV injection of 500mg of a new drug to a patient, the following data were obtained:

Collection Interval (hr)	Urine Volume (mL)	Drug conc in Urine (mg/mL)	$Cp_{t\text{-}mid}$ (mg/L)
0-2	125	1.776	15.9
2-4	150	0.933	10.0
4-6	175	0.504	6.3
6-8	138	0.403	4.97
8-10	163	0.215	2.51
10-14	313	0.112	1.24

a Estimate the biological half-life of this drug in this patient using urinary excretion data.

(8 marks)

b Estimate the renal clearance of this drug in this patient.

(6 marks)

c Calculate the fraction of the administered dose excreted unchanged in the urine from the available data.

(6 marks)

Question 5 (24 marks; Suggested time allocation 28 min)

Mr Z received a single oral dose of 5 mg of a bronchodilator that is completely absorbed after oral administration (F = 1). The following plasma concentration time data were obtained:

Time (hr)	Plasma Drug Concentration (ng/mL)	Time (hr)	Plasma Drug Concentration (ng/mL)
0	0.00	4.0	31.1
0.2	10.0	6.0	18.6
0.5	21.5	8.0	10.2
1.0	33.4	10.0	5.44
2.0	40.7	14.0	1.47
3.0	37.6		

a Plot the *plasma concentration-time* curve (with proper labels) and determine the elimination rate constant (k), and half-life ($t_{½}$) of this bronchodilator in Mr Z.

(8 marks)

b Use the *method of residuals* to calculate the absorption rate constant (k_a).

(8 marks)

c What is the *equation* that describes the plasma concentration time profile of this drug in Mr Z after oral administration?

(4 marks)

d Calculate the t_{max} and C_{max}.

(4 marks)

Question 6 (14 marks; Suggested time allocation 18 min)

Ms SNI, a 32-year-old 75kg female has been taking an oral dose of 200mg phenytoin daily to control her simple partial seizures. After one month of therapy, her average phenytoin plasma concentration was measured at only 5mg/L, which was insufficient to control her seizures. So her daily oral phenytoin dose was increased to 175 mg b.d. (i.e. twice daily). Since starting this increased daily dose her average plasma phenytoin concentration was 21 mg/L. Assuming that the volume of distribution of phenytoin is 0.75 L/kg and the absolute bioavailability of oral phenytoin is 100% (i.e., F = 1):

a Using the direct linear plot (Mullen Method – with proper labels), determine the V_{max} and K_m for phenytoin in this patient.

(8 marks)

b Recommend a dosage regimen to maintain steady-state plasma phenytoin concentration around 15mg/L (therapeutic range 10-20mg/L).

(2 marks)

c What will be the half-life ($t_{½}$) of phenytoin at steady-state if a dose of 175 mg every 12 hours was given to Mrs SNI?

(4 marks)

End of Section B

End of Exam Paper

PHA310 Pharmacokinetic Equations for Final Exam

Drug Absorption and Distribution

$$Rate\ of\ diffusion = \frac{DKS}{h}(C_{abs} - C_p)$$

$$Rate\ of\ transport = \frac{J_{max} \cdot C_{abs}}{K_m + C_{abs}}$$

$$logP = log\left[\frac{Drug\ concentration\ in\ n-octanol}{Drug\ concentration\ in\ water}\right]$$

$$pK_a = pH + log\frac{[protonated]}{[unprotonated]}$$

For weak acid: $pK_a = pH + log\frac{[HA]}{[A^-]}$

For weak base: $pK_a = pH + log\frac{[BH^+]}{[B]}$

Drug dissolution rate $\frac{dc}{dt} = \frac{DS}{h} \cdot (C_s - C_p)$

Distribution coefficient: $Kp_T = \frac{C_T}{C_B}$

$$Amount_T = Kp_T \cdot C_B \cdot V_T$$

$$V_d = \frac{Dose}{C}$$

$$V_d = V_p + V_t\left(\frac{f_{uP}}{f_{uT}}\right)$$

$$Loading\ dose = C \cdot V_d$$

Drug Elimination

Extraction ratio (ER): $E = \frac{Cp_a - Cp_v}{Cp_a}$

Hepatic ER: $E_H = \frac{CL_{int}}{Q_H + CL_{int}}$

$$E_H = \frac{f_u \cdot CL'_{int}}{Q_H + f_u \cdot CL'_{int}}$$

$$CL_{organ} = Q \cdot E$$

$$CL_{int} = \frac{Q_H \cdot E_H}{(1 - E_H)}$$

$$CL_H = Q_H \cdot \left[\frac{f_u CL'_{int}}{Q_H + f_u CL'_{int}}\right]$$

$$Elimination\ rate = CL_{organ} \cdot Cp_0$$

$$Maintenance\ dose\ rate\ (MDR) = CL \cdot C_{ss}$$

$$CL = \frac{Dose}{AUC}$$

Renal excretion: $\frac{dA_e}{dt} = k_e \cdot A$

$\frac{\Delta A_e}{\Delta t} = k_e \cdot V_d \cdot Cp_{t-mid}$
Renal Clearance: $CL = k_e \cdot V_d$
First-order Elimination
$C = C_0 \cdot e^{-kt}$
$lnC = lnC_0 - kt$
$logC = logC_0 - \frac{kt}{2.303}$
$t_{½} = \frac{0.693}{k}$
$k = \frac{CL}{V_d}$
$slope = -\frac{k}{2.303} = \frac{log\ y_2 - log\ y_1}{x_2 - x_1}$
Zero-order Elimination
$C = C_0 - kt$
$t_{½} = \frac{C_0}{2k}$
$slope = -k = \frac{y_2 - y_1}{x_2 - x_1}$
Area Under Curve
$AUC = \frac{C_0}{k} = \frac{Dose}{CL}$
$AUC = \left(\frac{C_0 + C_1}{2}\right)(t_1 - t_0) + \left(\frac{C_1 + C_2}{2}\right)(t_2 - t_1) + \left(\frac{C_2 + C_3}{2}\right)(t_3 - t_2) + \cdots + 1.44 \cdot C_{last} \cdot t_{½}$
Bioavailability
$F = \frac{AUC_{oral}}{AUC_{IV}}$
$F_{absolute} = \frac{AUC_{oral}}{AUC_{IV}} \cdot \frac{Dose_{IV}}{Dose_{oral}}$
$F_{relative} = \frac{F_{test}}{F_{standard}} = \frac{AUC_{test}}{AUC_{standard}} \cdot \frac{Dose_{standard}}{Dose_{test}}$
Drug Renal Excretion Rate Time Profile for Pharmacokinetic Calculations
Renal excretion rate time profile: $\frac{\Delta A_e}{\Delta t} = k_e \cdot A_0 \cdot e^{-kt}$
Total amount excreted: $A_{e\infty} = \frac{k_e}{k} \cdot A_0 = \frac{k_e}{k} \cdot Dose$
$fraction\ (f) = \frac{A_{e\infty}}{F \cdot Dose} = \frac{k_e}{k} = \frac{CL_R}{CL_T}$

$F_{absolute} = \frac{A_{e\infty\ oral}}{A_{e\infty\ IV}}$
$F_{relative} = \frac{A_{e\infty\ test}}{A_{e\infty\ standard}} \cdot \frac{Dose_{standard}}{Dose_{test}}$
$CL_R = \frac{A_{e\infty}}{AUC}$
Constant Rate IV Infusion
$K_0 = dose\ rate\ (or\ infusion\ rate)$
$Cp = \frac{K_0}{k \cdot V_d}(1 - e^{-kt})$
$Cp_{ss} = \frac{K_0}{k \cdot V_d} = \frac{K_0}{CL_T}$
Intermittent IV Infusion and First-order Elimination
$Cp = \frac{K_0}{V_d \cdot k}\left(1 - e^{-kt'}\right) + Cp_x \cdot e^{-kt'}$
$Cp_{\max ss} = \frac{K_0 \cdot \left(1 - e^{-kt'}\right)}{V_d \cdot k \cdot (1 - e^{-k\tau})}$
$Cp_{\min ss} = Cp_{\max ss} \cdot e^{-k(\tau - t')}$
$Cp_{average\ ss} = \frac{D}{CL \cdot \tau}$
Multiple Dose Administration
$Cp_{\max ss} = \frac{F \cdot D}{V_d(1 - e^{-k\tau})}$
$Cp_{\min ss} = Cp_{\max ss} \cdot e^{-k\tau}$
$Cp_{\max ss} - Cp_{\min ss} = \frac{Dose}{V_d}$
$Cp_{average\ ss} = \frac{F \cdot Dose}{CL \cdot \tau}$
$Cp_{average\ ss} = \frac{AUC}{\tau}$
$AUC_{0\to\infty}\ after\ a\ single\ dose = AUC_{0\to\tau}$ at steady state
$R_{accum} = \frac{1}{k \cdot \tau}$
Extravascular Administration
Zero-order absorption and first-order elimination
$Cp = \frac{K_0}{V_d \cdot k}(1 - e^{-kt})$

First-order absorption and elimination

$$Cp = \frac{F \cdot Dose \cdot k_a}{V_d(k_a - k)}(e^{-kt} - e^{-k_a t})$$

$$t_{max} = \frac{lnk_a - lnk}{k_a - k} = \frac{ln\left(\frac{k_a}{k}\right)}{k_a - k} = \frac{2.303 \cdot log\left(\frac{k_a}{k}\right)}{k_a - k}$$

$$C_{max} = \frac{F \cdot Dose \cdot k_a}{V_d(k_a - k)}(e^{-kt_{max}} - e^{-k_a t_{max}})$$

$$y - intercept = \frac{F \cdot Dose \cdot k_a}{V_d(k_a - k)}$$

$$AUC_{oral}|_{t=0}^{t=\infty} = \frac{F \cdot Dose}{CL_T}$$

With lag time t_0 $\quad Cp = \frac{F \cdot Dose \cdot k_a}{V_d \cdot (k_a - k)} \cdot (e^{-k(t-t_0)} - e^{-k_a(t-t_0)})$

Using Urinary Excretion Data to Calculate k_a

$$\frac{\Delta A_e}{\Delta t} = \frac{F \cdot Dose \cdot k_e \cdot k_a}{k_a - k} \cdot (e^{-kt} - e^{-k_a t})$$

$$A_e = \frac{F \cdot Dose \cdot k_e \cdot k_a}{k_a - k} \cdot \left(\frac{-e^{-k_a t}}{k_a} - \frac{e^{-kt}}{k}\right) + \frac{FDk_e}{k}$$

$$A_{e\infty} = \frac{k_e}{k} \cdot F \cdot Dose$$

Residuals Method or Wagner-Nelson Method to Determine k_a

$$Residuals = \frac{F \cdot Dose \cdot k_a}{V_d \cdot (k_a - k)} \cdot e^{-kt} - C_p$$

$$fraction\ of\ dose\ absorbed\ (t) = \frac{A_{at}}{A_{a\infty}} = \frac{Cp_t + k \cdot AUC|_{t=0}^{t=t}}{k \cdot AUC|_{t=0}^{t=\infty}}$$

$$fraction\ of\ dose\ remaining\ to\ be\ absorbed\ (t) = 1 - \frac{A_{at}}{A_{a\infty}}$$

Metabolite Pharmacokinetics

$$\frac{dA_{(m)}}{dt} = Ak - A_{(m)}k_{(m)}$$

$$Cp_{(m)} = \frac{k \cdot D}{V_{d_{(m)}}(k_{(m)} - k)}\left(e^{-kt} - e^{-k_{(m)}t}\right)$$

$$Cp_{(m)} = \frac{f_m \cdot k \cdot D}{V_{d_{(m)}}(k_{(m)} - k)}\left(e^{-kt} - e^{-k_{(m)}t}\right)$$

(f_m = fraction of administered dose being metabolised)

$$t_{max_{(m)}} = \frac{\ln\left(\frac{k_{(m)}}{k}\right)}{k_{(m)} - k}$$

$$AUC_{(m)} = \frac{f_{(m)} \cdot D}{CL_{T_{(m)}}}$$

$$\frac{AUC_{(m)}}{AUC} = \frac{f_m CL_T}{CL_{T_{(m)}}}$$

$$AUC'_{(m)} = \frac{M}{CL'_{T_{(m)}}}$$

(M = dose of the metabolite)

$$\frac{AUC_{(m)}}{AUC'_{(m)}} = \frac{f_m \cdot D \cdot CL'_{T_{(m)}}}{M \cdot CL_{T_{(m)}}} = f_m$$

$$V_{d_{(m)}} = \frac{M}{Cp_{0_{(m)}}} = \frac{CL_{T_{(m)}}}{k_{(m)}}$$

$$Metabolite\ formation\ clearance = f_m CL_T$$

$$\frac{Cp_{(m)\,ss}}{Cp_{ss}} = \frac{f_m CL_T}{CL_{T\,(m)}} = \frac{AUC_{(m)}}{AUC}$$

Nonlinear Pharmacokinetics

Rate of decline in the amount of drug in the body after single IV bolus

$$\frac{-dA}{dt} = \frac{V_{max} \cdot Cp}{K_m + Cp}$$

$$Cp = Cp_0 + K_m \cdot \ln\left(\frac{Cp_0}{Cp}\right) - \frac{V_{max} \cdot t}{V_d}$$

During multiple drug administration

$$\frac{F \cdot D}{\tau} = \frac{V_{max} \cdot Cp_{ss}}{K_m + Cp_{ss}}$$

$$Cp_{ss} = \frac{\left(\frac{F \cdot D}{\tau}\right) \cdot K_m}{V_{max} - \left(\frac{F \cdot D}{\tau}\right)}$$

$$CL_T = \frac{V_{max}}{K_m + Cp}$$

$$t_{½} = \frac{0.693 \cdot V_d}{V_{max}}(K_m + Cp)$$

Multicompartment Models

$$C_p = \frac{D \cdot (\alpha - k_{21})}{V_c \cdot (\alpha - \beta)} \cdot e^{-\alpha t} + \frac{D \cdot (k_{21} - \beta)}{V_c(\alpha - \beta)} \cdot e^{-\beta t}$$

$$C_p = A \cdot e^{-\alpha t} + B \cdot e^{-\beta t}$$

$A = \frac{D \cdot (\alpha - k_{21})}{V_c \cdot (\alpha - \beta)}$
$B = \frac{D \cdot (k_{21} - \beta)}{V_c(\alpha - \beta)}$
$\alpha + \beta = k_{12} + k_{21} + k_{10}$
$\alpha \cdot \beta = k_{21} \cdot k_{10}$
$\alpha = \frac{1}{2} \cdot \left[(k_{12} + k_{21} + k_{10}) + \sqrt{(k_{12} + k_{21} + k_{10})^2 - 4 \cdot k_{21} \cdot k_{10}}\right]$
$\beta = \frac{1}{2} \cdot \left[(k_{12} + k_{21} + k_{10}) - \sqrt{(k_{12} + k_{21} + k_{10})^2 - 4 \cdot k_{21} \cdot k_{10}}\right]$
$\beta = \frac{0.693}{t_{½\beta}}$
$\alpha = \frac{0.693}{t_{½\alpha}}$
$V_c = \frac{Dose}{Cp_0} = \frac{Dose}{A + B}$
$AUC\vert_{t=0}^{t=\infty} = \frac{A}{\alpha} + \frac{B}{\beta}$
$CL_T = \frac{Dose}{AUC\vert_{t=0}^{t=\infty}}$
$CL_T = k_{10} \cdot V_c$
$k_{21} = \frac{\alpha\beta}{k_{10}}$
$k_{12} = (\alpha + \beta) - (k_{21} + k_{10})$
$V_{d\,ss} = \frac{Cp_{ss} \cdot V_c + Cp_{ss} \cdot V_c \cdot \left(\frac{k_{12}}{k_{21}}\right)}{Cp_{ss}} = V_c + V_c \cdot \frac{k_{12}}{k_{21}} = V_c \cdot \left(1 + \frac{k_{12}}{k_{21}}\right)$
$V_{d\beta} = \frac{CL_T}{\beta} = \frac{V_c \cdot k_{10}}{\beta}$
$C_p = \left(\frac{k_a \cdot F \cdot D}{V_c}\right)\left[\frac{(k_{21} - \alpha) \cdot e^{-\alpha t}}{(\beta - \alpha) \cdot (k_a - \alpha)} + \frac{(k_{21} - \beta) \cdot e^{-\beta t}}{(k_a - \beta) \cdot (\alpha - \beta)} + \frac{(k_{21} - k_a) \cdot e^{-k_a t}}{(\alpha - k_a) \cdot (\beta - k_a)}\right]$
$Cp_{ss} = \frac{Infusion\ rate}{CL_T} = \frac{K_0}{CL_T}$
$Cp_{average\ ss} = \frac{F \cdot Dose}{CL_T \cdot \tau}$
$CL_R = \frac{\Delta A_e / \Delta t}{Cp_{t-mid}} = \frac{A_{e\infty}}{AUC\vert_{t=0}^{t=\infty}}$
$C_p = \left(\frac{D}{V_c}\right)\left[\frac{(k_{21} - \alpha) \cdot (k_{31} - \alpha)}{(\beta - \alpha) \cdot (\gamma - \alpha)} \cdot e^{-\alpha t} + \frac{(k_{21} - \beta) \cdot (k_{31} - \beta)}{(\alpha - \beta) \cdot (\gamma - \beta)} \cdot e^{-\beta t} + \frac{(k_{21} - \gamma) \cdot (k_{31} - \gamma)}{(\alpha - \gamma) \cdot (\beta - \gamma)} \cdot e^{-\gamma t}\right]$

Noncompartmental Models
$MRT = \frac{AUMC}{AUC}$
$AUC_{t-\infty} = \frac{C_{last}}{\lambda}$
$AUMC_{t-\infty} = \frac{t_{last} Cp_{last}}{\lambda} + \frac{C_{last}}{\lambda^2}$
$MRT_{oral} = MRT_{IV} + MAT$
$MRT_{IV\ infusion} = MRT_{IV} + \frac{T}{2}$
$CL_T = \frac{Dose_{IV}}{AUC_{IV}}$
$\frac{CL_T}{F} = \frac{Dose_{oral}}{AUC_{oral}}$
$V_{d\ ss} = CL_T \cdot MRT_{IV} = \frac{Dose_{IV} \cdot AUMC}{AUC^2}$
$V_{d\ ss} = CL_T \cdot MRT_{infusion} = CL_T \left(MRT_{IV} - \frac{T}{2}\right)$
$MRT_{IV} = \frac{1}{k}$
$MRT_{oral} = \frac{1}{k} + \frac{1}{k_a}$
$MAT = \frac{1}{k_a}$
$MRT_{infusion} = \frac{1}{k} + \frac{T}{2}$
$MRT_{IV\ 2\ comp} = \frac{1}{\alpha} + \frac{1}{\beta} - \frac{1}{k_{21}}$
$MRT_{oral\ 2\ comp} = \frac{1}{k_a} + \frac{1}{\alpha} + \frac{1}{\beta} - \frac{1}{k_{21}}$
Pharmacokinetic-Pharmacodynamic Modelling
$E = S \cdot C$
$E = E_o + S \cdot C$
$E = S \cdot \log C + I$
$E = \frac{E_{max} \cdot C}{EC_{50} + C}$
$E = \frac{E_{max} \cdot C^n}{EC_{50}^n + C^n}$

Renal Dysfunction

Cockcroft-Gault Equation

$$CrCL\ (mL/min) = \frac{(140 - age) \cdot (weight\ in\ kg)}{0.815\ \cdot\ Se_{Cr}\ (\mu mol/L)} or\ \frac{(140 - age) \cdot (weight\ in\ kg)}{72\ \cdot\ Se_{Cr}\ (mg/dL)}$$

For adult women, multiply the above equation by 0.85
[Weight = ideal weight (for obese person) or actual weight (whichever is lower)]

$$Kidney\ Function\ (KF) = \frac{CrCL_{failure}}{CrCL_{normal}}$$

$$Fraction\ (f) = \frac{A_{e\infty}}{Dose_{IV}} = \frac{A_{e\infty}}{F \cdot Dose_{oral}} = \frac{k_e}{k} = \frac{CL_R}{CL_T}$$

$$Dose_{failure} = Dose_{normal}[f \cdot (KF - 1) + 1]$$

$$t_{½_{failure}} = \frac{t_{½_{normal}}}{[f \cdot (KF - 1) + 1]}$$

Digoxin Pharmacokinetics

$$CL_{Digoxin}\ = 1.303\ CrCL + CL_{NR}$$

CL_{NR} = 40mL/min for patients with mild heart failure (NYHA CHF Classes I or II) or 20mL/min for patients with severe heart failure (NYHA CHF Classes III or IV)

$$V_{d\,Digoxin}\ = 226 + \frac{298 \cdot CrCL}{29.1 + CrCL}$$

Aminoglycosides Pharmacokinetics

$$k\ = 0.00293 \cdot CrCL + 0.014$$

Body Weight

$$BMI\ = \frac{Total\ Body\ Weight\ (TBW\ in\ kg)}{[Height\ (m)]^2}$$

$$Ideal\ Body\ Weight\ (IBW)\ = 49.9kg\ (45.4\ for\ females) + 0.89 \cdot (height\ in\ cm - 152.4)$$

$$Percent\ IBW\ = \frac{TBW}{IBW} \cdot 100$$

For males

$$Lean\ Body\ Weight\ (LBW)\ = (1.10 \cdot TBW) - (0.0128\ \cdot BMI \cdot TBW)$$

For females

$$Lean\ Body\ Weight\ (LBW)\ = (1.07 \cdot TBW) - (0.0148\ \cdot BMI \cdot TBW)$$

V_d for aminoglycosides in obese patients (TBW >130% IBW)

$$V_d\ = 0.26 \cdot [IBW + 0.4 \cdot (TBW - IBW)]$$

V_d for phenytion in obese patients

$$V_d\ = 0.7 \cdot [IBW + 1.33 \cdot (TBW - IBW)]$$

Paediatric Patients (Aminoglycosides)
$Loading\ dose_{infant(V_d \leq 0.4L/kg)} = Loading\ dose_{adult} \cdot \frac{BSA_{infant}}{BSA_{adult}}$
$Loading\ dose_{infant(V_d \geq 0.6L/kg)} = Loading\ dose_{adult} \cdot \frac{Body\ weight_{infant}}{Body\ weight_{adult}}$
$BSA\ (m^2) = 0.024265 \cdot Weight^{0.5378}(kg) \cdot Height^{0.3964}(cm)$ *(Haycock et al, 1978)*
Paediatric Patients (Hepatic Function Development)
$Dose_{infant(2-6\ months)} = Dose_{adult} \cdot \frac{Body\ weight_{infant}}{Body\ weight_{adult}}$
$Dose_{infant(age \geq 6\ months)} = Dose_{adult} \cdot \frac{BSA_{infant}}{BSA_{adult}}$
$Dose_{infant(age \geq 6\ months,\ UGT\ and\ CYP2D6)} = Dose_{adult} \cdot \frac{Body\ weight_{infant}}{Body\ weight_{adult}}$
Paediatric Patients (Renal Function Development)
$GFR\ (mL/min/1.73m^2) = k \cdot \frac{Length\ (cm)}{SeCr\ (mg/dL)} = k \cdot \frac{Length\ (cm)}{0.0113 \cdot SeCr\ (\mu mol/L)}$ *k = 0.413 (revised)*
$Dose_{infant(age \geq 1\ week)} = Dose_{adult} \cdot \frac{GFR_{infant\ (mL/min)}}{GFR_{adult\ (mL/min)}}$
$Dose_{infant(age \geq 2\ years)} = Dose_{adult} \cdot \frac{BSA_{infant}}{BSA_{adult}}$

End of Equations List