RAJIV GANDHI UNIVERSITY OF HEALTH SCIENCES, BANGALORE

SIXTH SEMESTER

BP 604T. BIO PHARMACEUTICS AND PHARMACOKINETICS

Learning objectives: Upon completion of the course student shall be able to:

1. To understand the basic concepts in bio-pharmaceutics and pharmacokinetics and their significance
2. Use of plasma drug concentration-time data to calculate the pharmacokinetic parameters to describe the kinetics of drug absorption, distribution, metabolism, excretion and elimination.
3. To understand the concepts of bioavailability and bioequivalence of drug products and their significance.
4. To Understand various pharmacokinetic parameters, their significance and applications

BP 604T. BIO PHARMACEUTICS AND PHARMACOKINETICS (BLUE PRINT)

Sl.No	Chapter	Marks Distribution					Total
		Must Know	Desirable to know	Long essay	Short essay	Short Answer	
Unit-I	**Introduction to Bio pharmaceutics** **Absorption**; Mechanism of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from Non per oral extra-vascular routes, **Distribution:** Tissue permeability of drugs, binding of drugs, apparent volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding. Kinetics of protein binding, Clinical significance of protein binding of drugs	**Absorption:** Mechanism of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from **Distribution:** Tissue permeability of drugs, binding of drugs, apparent volume of drug distribution, plasma and tissue protein binding of drugs, factors affecting protein-drug binding.	Non per oral extra-vascular routes, Kinetics of protein binding, Clinical Significance of protein binding of drugs extra-vascular routes, Protein binding of drugs	**10**	**5+5**	**2+2**	**24M**
Unit-II	**Elimination:** Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non renal routes of drug excretion of drugs **Bioavailability and Bioequivalence:** Definition and Objectives of	**Elimination:** Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs. **Bioavailability and Bioequivalence:** Absolute and relative bioavailability, measurement of bioavailability,	Renal clearance, Non renal routes of drug excretion of drugs. In-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, Poorly soluble drugs	**10**	**5+5**	**2+2**	**24M**

	bioavailability, absolute and relative bioavailability, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.	Methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.					
Unit-III	**Pharmacokinetics:** Definition and introduction to Pharmacokinetics, Compartment models, Non compartment models, physiological models, One compartment open model. (a). Intravenous Injection (Bolus) (b). Intravenous infusion and (c) Extra vascular administrations. Pharmacokinetics parameters- KE , t1/2, Vd, AUC, Ka, Clt and CL_R- definitions methods of eliminations, understanding of their significance and application	**Pharmacokinetics** Definition, Introduction to Pharmacokinetics, Compartment models, Non compartment models, physiological models, One compartment open model. (a). Intravenous Injection (Bolus) (b). Intravenous infusion and (c) Extra vascular administrations.	Pharmacokinetics parameters- KE , t1/2, Vd, AUC, Ka, Clt and CL_R- definitions Methods of eliminations, understanding of their significance and application Understanding significance of pharmacokinetics and application	**10**	**5+5**	**2+2**	**24M**
Unit-IV	**Multicompartment models:** Two compartment open model. IV bolus Kinetics of multiple dosing, steady state drug levels, calculation of loading and maintenance doses and their significance in clinical setting.	**Multi Compartment Models:** Two compartment open model. IV bolus Kinetics of multiple dosing, steady state drug levels,	Calculation of loading and maintenance doses Significance in clinical setting.	**---**	**5**	**2+2**	**09M**
Unit-V	**Nonlinear Pharmacokinetics:** a. Introduction, b. Factors causing Non-linearity. c. Michaelis-menton method of estimating parameters, Explanation with example of drugs.	**Nonlinear Pharmacokinetics:** a. Introduction, b. Factors causing Non-linearity. c. Michaelis-menton	Method of estimating parameters. Explanation with example of drugs.	**---**	**5+5**	**2+2**	**14M**
Total				**30**	**45**	**20**	**95M**

LONG ESSAYS

1. What are the assumptions made in developing pH partition hypothesis? What are the limitations of pH partition hypothesis?
2. Explain different pharmacokinetic models. What are the important points to be considered in developing equation for a two compartment model?
3. Explain different methods to enhance the dissolution of poorly soluble drugs.
4. Describe the various physiological barriers affecting distribution of drug.
5. Describe the various methods of assessment of bioavailability.
6. Discuss the one compartment open model for IV bolus administration.
7. Write a note on absorption and various mechanisms of drug absorption.
8. Define bioavailability, classify bioavailability, and write about bioequivalence study protocol.
9. Write about physicochemical and pharmaceutical factors effecting drug absorption.
10. Discuss biological and physicochemical factors influencing drug absorption.
11. Define bioavailability. Explain any two methods for measurement of bioavailability.
12. Define compartment. Discuss method of residuals/feathering method for deriving pharmacocokinetic parameters following one compartment model.
13. Define Biopharmaceutics. Discuss in detail kinetics of protein binding.
14. Discuss in detail drug metabolism and metabolic pathways of renal excretion.
15. Define pharmacokinetics. Derive pharmacokinetic parameters of drug administered by intravenous injection (bolus).
16. Classify factors influencing absorption drugs. Explain physicochemical factors in detail.
17. Define bioavailability. Write its objectives. Explain different methods for measurement of bioavailability.
18. Derive various pharmacokinetic parameters for intravenous infusion by two compartment model.
19. Define drug absorption. Explain various mechanisms of drug absorption through GIT.
20. Define bioavailability. Discuss the different methods for measurement of bioavailability.
21. Explain determination of pharmacokinetic parameters from plasma concentration data after administration of drug by I.V. infusion.
22. List the various processes through which drugs can cross the biological membrane. Describe absorption of drugs from non per oral extra-vascular routes.
23. Explain various methods to enhance the dissolution rate of poorly soluble drugs.
24. Explain determination of pharmacokinetic parameters from plasma concentration data after administration of drug I.V.bolus.
25. Discuss in detail the various physiological factors affecting drug absorption.
26. Define metabolism. Explain phase I reactions.

27. Discuss in detail one-compartment open model for a drug administered as I.V. Bolus. Give the schematic representation, graphs and equations for the same.
28. Define drug distribution. Describe the various factors affecting drug distribution.
29. Define bioavailability. Explain pharmacokinetic methods for assessment of bioavailability.
30. Discuss in detail one-compartment open model for a drug administered as I.V. infusion. Give the schematic representation, graphs and equations for the same.

SHORT ESSAYS

1. What do you mean by the term clearance and how will you determine renal clearance.
2. Write the advantages and limitation of multiple dose study
3. Explain various methods to determine Michaelis-Menten rate constant.
4. Discuss about criteria for obtaining a valid urine excretion data.
5. Derive an equation to determine concentration of drug given by i.v bolus route following 1 CBM kinetic.
6. Explain the role of plasma proteins in drug distribution
7. What is a compartment model? Discuss the various types of compartment models.
8. Explain apparent volume of distribution and distribution co-efficient.
9. Explain the factors affecting drug distribution.
10. Write about pH partition theory and its limitation.
11. Explain Wagner –Nelson method along with its advantages and limitations.
12. Briefly explain about mechanism of renal clearance.
13. Brief note on dosage regimen adjustment in patient with renal failure.
14. Describe briefly on absolute and relative bioavailability.
15. Enumerate different methods for enhancement of dissolution of poorly soluble drugs.
16. Discuss about different pharmacokinetic parameters.
17. Enumerate various factors affecting protein binding and explain protein related factors.
18. Explain sigma-minus method.
19. Write in detail about physiological factors effecting drug absorption.
20. Write a note on application of pharmacokinetic models.
21. Write any two methods to determine bioavailability.
22. Write a note on metabolic pathway of renal excretion of drug.
23. Explain term *in-vitro in-vivo* correlation.
24. Enumerate the kinetic of protein –drug binding and represent different plots.
25. Explain about pseudo polymorphism and biopharmaceutical classification system.
26. Determination of absorption coefficient by back residual method.
27. Write a note on mamillary and caternary model.

28. Enumerate factors affecting protein drug binding. Explain any two factors.

29. Compare and contrast active and passive diffusion of drug absorption.

30. Define clearance. Write a note on renal clearance

31. Define dissolution. Explain various methods to enhance the dissolution of poorly soluble drugs.

32. Write a note on applications of pharmacokinetics in pharmacy.

33. Describe non-compartment models.

34. Explain drug accumulation during multiple dosing.

35. Write a note on Michaelis-Menten equation.

36. Estimate K_m and V_{max}.

37. Write a note on non per oral extra vascular routes for drug absorption.

38. Explain clinical significance of protein binding.

39. Enlist in vitro dissolution models. Explain USP type I apparatus.

40. Write a note on IVIVC correlations.

41. Write a note on physiological models.

42. Significance of compartment modeling.

43. Explain two compartment open model.

44. Explain factors causing non-linearity.

45. Write the objectives and significance of non linear pharmacokinetics.

46. Enlist various mechanism of drug absorption. Explain active and passive diffusion.

47. Write a note on tissue permeability of drugs.

48. Write a note on pathways of renal excretion of drugs.

49. Explain bioequivalence studies in brief.

50. Define compartment. Write its applications in pharmacokinetic analysis.

51. Applications and significance of pharmacokinetics.

52. Explain two compartment open model.

53. Write a note on factors causing nonlinearity.

54. Explain the method to determine nonlinearity.

55. Explain the factors affecting protein binding of drugs.

56. Write a note on tissue permeability of drugs.

57. Define metabolism. Write a note on glucuronidation.

58. Write a note on non renal excretion of drugs.

59. What are pharmacokinetic models? What is the importance and utility of such models?

60. Discuss about the blood level curves of a drug administered by I.V. bolus and oral routes.

61. Explain in brief what is multi compartment model?

62. Explain about Michaelis - Menten's equation?

63. How do you estimate K_m and V_{max} after i.v. bolus administration of drug following non-linear kinetics?

64. Define biopharmaceutics and discuss its role in formulation development.

65. Write in detail about protein binding and its significance.

66. Write a note on renal excretion of drugs.

67. Explain bioequivalence studies.

68. Discuss about the blood level curves of a drug administered by I.V. infusion and oral routes.

69. What are pharmacokinetic models? Explain various types with their significance.

70. Estimate one compartment model parameters by using the method of residuals**.**

71. Explain about Michaelis - Menten's equation?

72. Write a note on determination of Km and Vmax at steady state concentration.

73. Discuss the differences between passive diffusion and active transport of drugs.

74. Define volume of administration and give its significance.

75. Explain the factors affecting renal excretion of drugs.

76. Define bioavailability. Mention the objectives of bioavailability studies.

77. Write the importance of Compartment modeling in pharmacokinetic study.

78. How do you determine KE using rate of excretion method from urine data.

79. Define loading and maintenance dose. Give the formula for the same.

80. Explain Michaelis –Menten equation in determining non-linearity.

81. Explain the various factors leading to non-linearity.

82. Explain in vitro and in vivo methods for determining absorption of drugs.

83. Explain kinetics of drug protein binding.

84. Discuss the various study designs for performing bioequivalence studies.

85. Explain various factors affecting biotransformation of drugs.

86. Write the applications of pharmacokinetic models.

87. Explain the assumptions of one-compartment open model.

88. Give schematic representation of two and three compartment models with brief explanation.

89. How do you estimate Km and Vmax.

90. Explain the causes of nonlinearity.

SHORT ANSWERES

1. Drug dissolution rate and bioavailability

2. Define Solid dispersion.

3. Maximum Safe concentration, Minimum effective concentration.

4. Loading dose and maintenance dose.

5. Difference between biopharmaceutices and pharmacokinetics.

6. Why non linear kinetics are called dose dependent kinetics.

7. Pharmaceutical equivalence and therapeutic equivalence.

8. Flip-flop phenomena and lag time.

9. Define T_{max}, $C_{max.}$

10. Pharmacodynamic drug interaction.

11. USP type-II dissolution testing apparatus.

12. Biological half life of a drug.

13. What is meant by compartment models.

14. Define Extraction ratio.

15. Mean residence time.

16. Michaelis-Menten equation.

17. Bioavailability and Bioequivalence.

18. Endocytosis.

19. Inclusion complex.

20. Curve fitting method.

21. Proteins responsible for protein binding.

22. Limitation of urine data for calculation of pharmacokinetics.

23. Clinical pharmacokinetics and its significance.

24. Apparent volume of distribution and its significance.

25. Facilitated diffusion.

26. Non-linear kinetic.

27. Gastric emptying time.

28. Tissue permeability of drug.

29. ABC transporter.

30. Plateau principle.

31. Define apparent volume of distribution.

32. Write any two clinical significance of protein binding.

33. Define bioequivalence and therapeutic equivalence.

34. List out non renal routes of drug excretion.

35. Define caternary model and write its one application.

36. Define Biological half-life.

37. Define dosage regimen.

38. Enlist factors causing non-linearity.

39. Define loading and maintenance dosing.

40. Define mixed order kinetics.

41. Define absorption and distribution of drugs.

42. Enlist physicochemical factors affecting drug absorption.

43. Enumerate different methods to enhance dissolution of poorly soluble drugs.

44. Objectives of bioavailability.

45. Define intravenous infusion.

46. Plot plasma concentration vs time profile.

47. Define intravenous bolus injection.

48. Plot multiple dosage regimens.

49. State Michaelis-menten equation.

50. Enlist the drugs follows non-linear pharmacokinetics.

51. Pore transport in absorption.

52. Enlist factors affecting protein binding.

53. Enumerate various dissolution models.

54. Enlist methods to enhance the dissolution rate of poorly soluble drugs.

55. Define physiological model and write its one application.

56. Define Biological half-life.

57. Significance of loading dose in clinical setting.

58. Define steady state in drug level study.

59. Define nonlinear-pharmacokinetics.

60. Define mixed order kinetics.

61. Define biopharmaceutics and drug protein binding.

62. How components of gastrointestinal fluid affect absorption of drugs.

63. Define absolute and relative bioavailability.

64. Enlist non renal routes of drug excretion.

65. What factors affect half life of the drugs?

66. Define volume of distribution, Write its importance.

67. Define loading dose and maintenance dose.

68. What is the significance of K_m and V_{max}?.

69. Compare the concept of linear and non linear pharmacokinetics.

70. Why is it important to monitor drug levels carefully for dose dependency?

71. What is hepatic first pass effect?

72. What is the influence of GI pH on drug absorption?

73. Enlist objectives of bioavailability studies.

74. Define clearance. What is its unit?

75. Define C_{max} and AUC.

76. Define apparent volume of distribution and give the mathematical equation to calculate it.

77. Define loading dose and maintenance dose.

78. What do you mean by central and peripheral compartment in two compartment model?

79. Define dose dependent kinetics.

80. Compare the concept of linear and non linear pharmacokinetics.

81. What is polymorphism.

82. Define protein binding.

83. What is clearance? Give the formula for same.

84. Give the significance of bio-equivalence.

85. What are the limitations of one compartment model.

86. Write equation for zero order half life and first order half life.

87. Give the schematic representation of two compartment open model-IV bolus.

88. Define Biological half-life.

89. What is multi compartment model?

90. What is Km and Vmax?

91. What is Pinocytosis and phagocytosis.

92. What is the effect of food on absorption of drugs?

93. Define biotransformation.

94. Write the formula to calculate hepatic extraction ratio.

95. What is zero order reaction?

96. Draw the blood level profiles for oral administration.

97. Define dosing frequency.

98. Enlist different pharmacokinetic parameters.

99. Name two parameters used in adjusting dosage regimen.

100. Give Michaelis-Menton equation. Explain the terms.