UNIVERSITY OF THE WEST INDIES, ST AUGUSTINE

FACULTY OF MEDICAL SCIENCES
SCHOOL OF PHARMACY

BACHELOR OF SCIENCE IN PHARMACY DEGREE

COURSE SYLLABUS

COURSE TITLE:	BIOPHARMACEUTICS, NEW DRUG DELIVERY SYSTEMS & DEVICES
COURSE CODE:	PHAR2213
DURATION:	4 HOURS/Week
CREDIT VALUE: **(Semester II)**	4

DESCRIPTION

Biopharmaceutics course seeks to educate and train candidates in the principles underlining drug absorption, distribution, metabolism and excretion (ADME) following its administration to human or animal subjects. The course places emphasis on the dependence of drug absorption on the physical and chemical nature of drug substances, the effect of dosage form in which it is designed and the factors related to the physiologic and pathologic conditions of the subjects to which it is administered. The aim is to develop in the candidate the ability to integrate all these factors holistically in optimizing therapeutic benefit to the patient while minimizing adverse or untoward effects of medicinal products. In addition, the course would train the candidates in novel delivery technologies that are currently being employed for enhancing drug delivery to various targets in the body.

OBJECTIVES

On completion of the course the student should be able to:

a. Discuss factors that influence absorption, distribution, metabolism and excretion of the drugs in the body.

b. Explain how dosage forms and presentations may affect the delivery of drug substances to various parts of the body, particularly the site of action

c. Explain the concepts of bioavailability, bioequivalence and drug products selection and substitution.

d. Describe the drug interactions, which occur during absorption, distribution and elimination of drugs and how these interactions influence the therapeutic effects of particular drugs.

e. Describe the features and explain the design and mechanisms of drug delivery via some novel delivery systems.

PART A: BIOPHARMACEUTICS

UNIT ONE - General introduction – 1 Hour

Unit Objectives – At the end of this unit, students will be able to:

- Discuss the sequence of events heralding the movement of drug molecules from the administered dosage forms into the systemic circulation
- Relate the chemical nature of drug substances to the anatomy and physiology of the sites of their absorption in predicting drug absorbability

Unit Contents

- Definitions – Biopharmaceutics, pharmacokinetics.
- General overview of factors influencing the activity of drugs.
- Factors influencing the time course of drug in the systemic circulation
- Structure of the gastrointestinal tract in relation to drug absorption

UNIT TWO – Drug Dosage Forms and Routes of Administration – revision (1 hour) – Dr. S. Adebayo

Unit Objectives - At the end of this unit, students will be able to:

- Review the different routes of drug administration and barriers to the systemic availability of drugs
- Review the different dosage forms applicable to specific routes of administration
- Discuss how dosage form design and manufacturing variables impact of drug dissolution and absorption from various dosage forms
- Given a drug's physicochemical properties, dose size and site of action, select the most appropriate dosage form and route of administration to optimize therapeutic effect of drug in the patient.

Unit Contents

- Routes of administration – per oral and parenteral routes. Buccal & sublingual, rectal, subcutaneous, intramuscular & intravenous routes, topic and other routes of drug administration.
- Dosage forms – Solution, suspension, capsule, tablets, modified release dosage forms
- Review of BP/USP procedures for evaluation of physical and bioavailability potential of drugs in dosage form

UNITTHREE – Physico-chemical properties of drug substances that affect dissolution and absorption – Revision (1 Hour) – Dr. S. Adebayo

Unit Objectives - At the end of this unit, students will be able to:

- Relate the physical and chemical nature of drug substance to its dissolution and absorption potential
- Apply the Noyes-Whitney equation to define the parameters for controlling dissolution rate of drug from dosage forms
- Apply the pH-partition theory to the prediction of the proportion of a drug in dosage form that will be present in absorbable form at different sites along the GIT

Unit Contents

- Effects of physiochemical properties on drug dissolution and absorption – wetting, solubility, ionization potential, partition coefficient, FDA BCS Classification System
- Quantitative relationship between drug pKa and dissolution fluid's pH in predicting drug absorption.
- Concepts of druggability and "Lipinski's Rule of Five"
- Factors controlling drug dissolution; Noyes-Whitney equation.
- Choice of molecular forms of drug to control dissolution and absorption - Influence of lipid solubility, particle size, salt formation, pro-drugs, armophism/polymorphism, hydration/solvation, complexation, clathrate forms, absorption and adsorption.

UNIT FOUR - BIOLOGIC FACTORS INFLUENCING DRUG ABSORPTION – 3 HOURS

Unit Objectives - At the end of this unit, students will be able to:

- Identify the effect of organism's physiology and anatomy on drug release and absorption
- Discuss the various mechanisms by which drug substances can traverse the biomembrane
- Discuss the factors that can influence the residence time of drug molecules at different sites along the GIT

Unit Contents

- Influence of biologic factors on drug absorption.
- Membrane physiology and organ-specific membrane structure
- Transport mechanisms - Passive diffusion (Fick's First Law of Diffusion), active transport, carrier- mediated, endo-cytosis, pino-cytosis, phagocytosis, ion-pair transport
- Effects of GI physiology and gastric emptying on drug absorption.
- Factors affecting gastric emptying rate
- Effects of co-administration of foods and other drugs on drugs absorption

UNIT FIVE – Bioavailability: 6 Hours (Dr. S. Adebayo)

Unit Objectives - At the end of this unit, students will be able to:

- Discuss the concept of bioavailability & bioequivalence
- Design and implement simple bioequivalence testing of drug products
- Identify and calculate bioequivalence parameters from graphical and non-graphical plasma concentration-time profiles of drug in human and animal subjects
- Assess the bioequivalence or in-equivalence of drug products
- Combine the knowledge of physical and bioequivalence drug qualities and price of products to arrive at indices of product utility for making rational generic drug product selection that optimizes benefit while minimizing cost.

Unit Contents

- Concept of bioavailability & bioequivalence
- Historical perspectives of bioequivalence testing and FDA regulations of drug product quality
- Bioavailability parameters – Maximum plasma concentration (Cmax), Time to reach maximum concentration (Tmax), elimination half-life;, Area under the plasma concentration-time curve (AUC). Computation of AUC – graphical trapezoidal method, empirical mathematical methods
- Relative and absolute bioavailability.
- Calculation of bioavailability & bioequivalence parameters – Methods of residuals, Wagner-Nelson Method, calculation of bioavailability factor (F value).
- Bioequivalence and generic substitution – decision making tree.
- Design and implementation of bioavailability/bioequivalence studies: Reasons for bioequivalence studies; Bioavailability study characteristics - Drug, subjects characteristics and number; Study design – Cross over design, randomization of subject allocation and product assignment; Sample collection and assay; Analysis and statistical quality control of data (F-test, t-test and Analysis of variance, ANOVA).

UNIT SIX – Systemic Distribution of Absorbed Drug Molecules: 4 Hours (Dr. S. Adebayo)

Unit Objectives – At the end of this unit, students will be able to:

- Describe the processes by which drugs absorbed into the systemic circulation are distributed throughout the body
- Describe the patterns of distribution that drugs may reflect in the body
- Discuss the concept of "Volume of Distribution"
- Explain the effect of protein binding on patterns of drug distribution
- Distinguish between Extent and Rate of drug distribution and identify the factors that would affect each parameter
- Discuss various methods for the assessment of protein binding and the significance of protein binding in therapeutics

Unit Contents

- Patterns of drug distribution
- Rate of drug distribution – Blood perfusion, membrane permeability
- Extent of drug distribution – Lipid solubility (partition coefficient), pH-pKa interaction, plasma protein & intracellular binding.
- Other factors affecting drug distribution - placental uptake, salivary, biliary and enterohepatic recycling.
- Significance of protein binding: extent of binding and binding affinity; protein binding interactions – displacement from binding site
- Protein binding determination

UNIT SEVEN - Metabolism - Termination of drug action – 4 Hours (Dr. S. Pandey)

Unit Objectives – At the end of this unit, students will be able to:

- Describe the various processes by which drugs can be metabolized in the body
- Discuss the concept of "Drug Clearance" and its relationship with drug duration of action and metabolic rate
- Discuss the relationship between parameters of hepatic clearance, hepatic blood flow (perfusion), fraction unbound and free intrinsic clearance
- Explain the processes by which enzyme inhibition and induction modulate drug metabolism
- Apply the knowledge of pattern and mechanisms of metabolism to drug product selection, administration (dose size and frequency)

Unit Contents

- Metabolic processes - phase one and phase two reactions
- Phase one reactions: oxidation, reduction, hydrolysis.
- Phase two reactions: conjugation via glucuronidation, acylation, sulphate conjugation and glycine addition
- Capacity limited and flow limited drugs
- Factors affecting metabolism: genetics; disease states, physiology of subject, demography, concurrent drug administration -etc.

- Enzyme induction and inhibition

UNIT EIGHT - Drug excretion – renal, salivary and biliary – 4 Hours (Dr. S. Pandey)

Unit Objectives - At the end of this unit, students will be able to:

- Give illustrative description of kidney and its excretory functional unit
- Discuss various processes by which drugs are excreted via the kidneys
- Discuss the procedures for measuring renal clearance and the analysis and interpretation of the results in subject's health status assessment
- Discuss other non-renal processes of drug excretion

Unit Contents

- Kidney – the major organ of drug excretion; Nephron – the functional unit of the kidney
- Processes of drug excretion by the kidneys – glomerular filtration, tubular secretion and tubular reabsorption
- Renal and non-renal clearance.
- Biliary excretion and entero-hepatic circulation
- Salivary Excretion
- Pulmonary excretion

PART B: **THERAPEUTIC SYSTEMS & NOVEL DRUG DELIVERY DEVICES 24 Hours**

Therapeutic systems & Novel drug delivery devices

Objectives - At the end of this unit, students will be able to:

- Review the design and construction of novel drug delivery systems
- Identify the benefits and limitations of various therapeutic systems
- Counsel patients and other members of the Health Care Delivery System on the selection and proper administration of various therapeutic systems

Unit Contents

- Concepts in modified release drug delivery systems: Terminologies (Controlled, sustained, delayed release, etc products) – 4 Hours **(Dr. S. Adebayo)**
- Oral therapeutic systems – OROS Push-Pull, Osmotic Delivery devices, Matrix and Membrane controlled Delivery devices – design, construction and applications – 2 Hours **(Dr. S. Adebayo)**
- Transdermal Delivery System - design, construction and applications – 2 Hours **(Dr. S. Adebayo)**
- Depot injections and Intrauterine delivery devices - design, construction and applications – 2 Hours **(Dr. S. Adebayo)**
- Nasal and Pulmonary drug delivery system – 4 Hours **(Dr. S. Pandey)**
- Targeted drug delivery system – 6 Hours **(Dr. S. Pandey)**
- Biotechnology drug products delivery – 4 Hours **(Dr. S. Adebayo)**

ASSESSMENT

In-course tests/Assignments/Problem papers		**40%**
Written Test	30 %	
Assignment	10%	
Final Examination		**60%**

TEXTBOOKS

REQUIRED

1. Shargel, L., Wu-Pong, S. and Yu, A. B. C. – Applied Biopharmaceutics and Pharmacokinetics 4th Edition (2005), McGraw-Hill (New York)
2. Micheal E. Aulton, Pharmaceutics: The Science of Dosage Form Design by, 2nd edition, 2002, Churchill Livingstone
3. Ansel, H. C., Allen, L. V. & Popovich, N. G. Pharmaceutical Dosage Forms and Drug Delivery systems, Lippincott Williams & Wilkins, 1999.

REFERENCES

J. E. Hoover, Mgn ed. Remington: The Science and Practice of Pharmacy, 20th edition (2002).

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