

RAJIV GANDHI PROUDYOGIKI VISHVA VIDYALYA**M. Pharm. (Pharmaceutics)****III Semester Elective Course Contents****ELECTIVE I****MPY 301 PCS : MODULATED RELEASE ORAL DRUG DELIVERY SYSTEMS****Unit I**

Diffusion and dissolution controlled drug delivery systems: Designing of diffusion and dissolution controlled matrix. Higuchi, Krosmayer Peppas and Hixon Crowell's models for drug release. Design, fabrication and release mechanism of gastroretentive dosage forms.

Unit II

Site specific oral drug delivery systems: Designing of oral mucosal drug delivery systems, buccal patches /tablets, medicated chewing gum, and lozenges. Osmotic tablets, colonic drug targeting. Pulsincaps, hydrophilic sandwich, Eaglet technology, and Enterion technology. Targeting through Peyer's patches lymphatic system.

Unit III

Novel oral drug delivery technologies: Study of TIMERx[®], MASRx[®], COSRx[®], RingCap[®], Smatrix[®], TheriForm[®], DissoCubes[®], Orasolv[®] and Durasolv[®] and other novel patented technologies developed for various controlled and sustained /fast release oral drug delivery systems.

Unit IV

Pelletization technologies: Designing of modulated release drug delivery systems by pelletization techniques: Layering, coating pan, Wurster coater, centrifugal granulation, extrusion-spheronization, cryopelletization, melt spheronization, and spray drying and spray congealing techniques.

Unit V

Modified release liquid drug delivery systems: Dispersed and colloidal drug delivery systems. Sustained release suspensions, multiple emulsions, self emulsifying drug delivery systems (SEDDS), liquid crystals, in-situ gels.

Books and references recommended:

1. Gilbert S. Banker, Christopher T. Rhodes, *Modern Pharmaceutics*, Marcel Dekker.
2. Donald D. Wise, *Handbook of pharmaceutical controlled release technology*, Marcel Dekker.
3. J.R. Robinson, V. H.L. Lee, *Controlled drug delivery: fundamentals and applications*, Marcel Dekker.
4. B. Wang, T. Sihaan, R. Soltero, *Drug delivery principles and applications*, Wiley Interscience.
5. T. K. Ghosh, W. R. Pfister, *Drug delivery to oral cavity: molecules to market*, Taylor and Francis.
6. M. J. Rathbone, J. Hadgraft, M. S. Roberts, *Modified-release drug delivery technology*, Marcel Dekker.
7. A. M. Hinary, A.W. Lloyd, J. Swarbrick, *Drug delivery and targeting*, Taylor and Francis.

RAJIV GANDHI PROUDYOGIKI VISHVA VIDYALYA**M. Pharm. (Pharmaceutics)****III Semester Elective Course Contents****ELECTIVE II****MPY 302 PCS : PARENTERAL, INHALATION & INTRANASAL DRUG DELIVERY TECHNOLOGY****Unit I**

Parenteral formulations of peptides and proteins: Detailed study of protein and peptide characteristics, formulation principles, compatibility with packaging components and infusion sets, common stabilizers used for development of parenteral formulations of peptides and proteins. Study of marketed parenteral products of peptides and proteins.

Unit II

Parenteral controlled drug depot systems: Designing of depot systems, formulation aspects, methods of preparation and characterization. In-vitro-in-vivo correlation of depot systems based on oil injection, suspension, emulsion, mixed micelles, liposome, and microsphere. Study of marketed and patented depot technologies: Atrigel[®], Lupron[®] Depot, Trelstar[®] Depot, Consta[®], Microsieve[®].

Unit III

Parenteral implants: Study of host response to long acting implants. Material of construction, methods of sterilization, release rate modulation, kinetics of release of drug from implantable drug delivery systems: Controlled-release micropump, drug-eluting stents, peristaltic, osmotic, propellant-driven, and positive displacement pumps.

Unit IV

Inhalation drug delivery systems: Metabolism and drug clearance mechanisms of lungs, pharmacodynamics and pharmacokinetics of therapeutic aerosols, effect of physical factors, breathing pattern, airway geometry, and mechanistic factors on drug delivery to lungs. Drug targeting to the lung: chemical and biochemical considerations. Study of dry powder inhalers (DPI), metered dose inhalers (MDI), delivery of peptides and vaccines through lungs.

Unit V

Intranasal drug delivery systems: Intranasal drug administration, nasal drug delivery devices. Intranasal drug delivery systems. Application of intranasal route for improving bioavailability, site specific and targeted drug delivery.

Books and references recommended:

1. Anthony J. Hickey, *Pharmaceutical Inhalation Aerosol Technology*, Marcel Dekker.
2. J. Swarbrick, *Injectable dispersed systems formulation, processing, and performance*, Teylor & Francis.
3. J. Swarbrick, J. C. Boylan, *Encyclopedia of pharmaceutical technology: Volume 8*, Marcel Dekker.
4. V. V. Ranade, M. A. Hollinger, *Drug delivery systems, Ed. 2*, CRC Press.
5. K. E. Avis, H. A. Lieberman, L. Lachman, *Pharmaceutical dosage forms: parenteral medications, Vol 2*, Marcel Dekker.

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III Semester Elective Course Contents

ELECTIVE III

MPY 303 PCS : NANO DRUG DELIVERY SYSTEMS

Unit I

Manufacturing of nanocarriers: Procedures involved in design and development of various nanosized drug delivery systems: nanocrystals, nanoparticles, nanocapsules, nanofibers, dendrimers, solid lipid nanoparticles, liposomes, fullerenes, i.e., carbon nanotubes, nanorods, and self-assembling nanostructures.

Unit II

Target oriented nanocarrier based drug delivery systems: Rational for targeted drug delivery, biological processes involved, cellular uptake and processing transport across epithelium, extravasation, lymphatic uptake. Pharmacokinetic and pharmacodynamic considerations.

Unit III

Long-circulating polymeric nanoparticles: Rational of long circulation and mechanism of clearance of nanoparticles from body. Chemistry involved in PEGylation of nanocarriers. Stealth nanoparticles. Bioconjugation, antibodies based mechanism.

Unit IV

Nanoparticle and targeted systems for cancer diagnosis and therapy: Targeted delivery through enhanced permeability and retention. Folate receptors, Targeting through angiogenesis, Targeting to specific organs or tumor types, Tumor-specific targeting: Breast cancer, Liver, Targeting tumor vasculature for Imaging.

Unit V

Nanosized materials used in diagnosis: Nanosized materials used in diagnosis of cancer and other critical diseases, MRI contrast enhancement, and in diagnostic kits.

Books and references recommended:

1. Gilbert S. Banker, Christopher T. Rhodes, *Modern Pharmaceutics*, Marcel Dekker.
2. R. B. Gupta, U. B. Kompella, *Nanoparticle technology for drug delivery*, Taylor & Francis.
3. Deepak Thassu, Michel Deleers, Yashwant Pathak, *Nanoparticulate drug delivery systems*, Informa healthcare.
4. Mansoor M. Amiji, *Nanotechnology for cancer therapy*, CRC Press.

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III Semester Elective Course Contents
ELECTIVE IV
MPY 304 PCS : BIOMATERIALS FOR DRUG DELIVERY

Unit I

Biomaterials: Introduction, classification, mechanical, surface, electrochemical, & physiochemical properties of biomaterials: metallic, ceramic, polymeric, composite, biodegradable hydrogels, and biologic biomaterials.

Unit II

Biodegradable polymers: Mechanisms of polymer degradation, factors affecting biodegradability, various methods to study biodegradability: enzyme assays, plate tests, respiration tests, gas (CO₂ or CH₄) evolution tests, radioactively labeled polymers. Study of segmented copolyesters with prolonged strength retention profiles, polyaxial crystalline fiber-forming copolyester, polyethylene glycol-based copolyesters, cyanoacrylate-based systems as tissue adhesives, chitosan-based systems.

Unit III

Development and applications of new systems: Fabrication of crystalline fiber-forming aliphatic copolyesters, medical absorbable devices, tissue engineering systems, synthetic vascular constructs, implantable insulin controlled release systems, absorbable delivery systems, tumor immunotherapeutic systems.

Unit IV

Testing of biomaterials: Biocompatibility, blood compatibility and tissue compatibility of biomaterials. In-vitro and in-vivo testing of toxicity, sensitization, carcinogenicity, mutagenicity testing of biomaterials.

Unit V

Regulatory aspects of biomaterials: Regulatory aspects of biomaterials and their approval status in various countries. Toxicity and interaction of biomaterials with body components.

Books and references recommended:

1. Sujata V. Bhatt, *Biomaterials*, Springer, 2002.
2. Buddy D. Ratner, Fredrick J. Schoen, Allan S. Hoffman, and Jack E. Lemons “*Biomaterials Science: An introduction to Materials in medicine*, Academic Press, 2004.
3. Jonathan Black, *Biological Performance of materials*, Taylor & Francis, 2006
4. C.P.Sharma & M.Szycher, *Blood compatible materials and devices*, Technomic Publishing Co. Ltd., 1991.
5. Piskin & A.S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers, 1986
6. J. B. Park, *Biomaterials - Science and Engineering*, Plenum Press, 1984.