

## Sterile Product Development Formulation Process Quality And Regulatory Considerations Aaps Advances In The Pharmaceutical Sciences Series

No other area of regulatory compliance receives more attention and scrutiny by regulatory authorities than the regulation of sterile products, for obvious reasons. With the increasing number of potent products, particularly the new line of small protein products, joining the long list of proven sterile products, the technology of manufacturing ster

This up-to-the-minute reference delineates-in a systematic fashion-the appropriate, sequential steps for the formulation of safe, effective, stable, and marketable liquid parenteral biopharmaceutical products-covering fundamentals and essential pathways for each phase as well as its purpose, function, and relation to other stages in the product development process. Written by experts currently involved in state-of-the-art advances in the pharmaceutical drug industry, *Development of Biopharmaceutical Parenteral Dosage Forms* details biopharmaceuticals that are licensed or undergoing clinical development, including genetically engineered cell and engineered vectors in the fermentation process describes purification and characterization techniques for rDNA therapeutics, discussing several types of unit operations for isolation, purification, and characterization considers preformulation and formulation requirements, such as physicochemical properties, drug delivery, stability studies programs, deactivation/denaturation routes, selection of compatible excipients, and regulatory compliance elucidates basics of analytical techniques, methods development, separation methods using chromatographic and electrophoretic techniques, and bioactivity methods covering bioassays and immunoassays for quantifying the stability of biological activity shows how to select the appropriate filter for maximizing compatibility and minimizing adsorption and inactivation, examining topics from basic filtration theories to future trends reviews the selection process for compatible elastomeric closures, analyzing physical, chemical, toxicological properties, protein adsorption on elastomeric surfaces, strategies to reduce/eliminate adsorption, and specialized containers for biotechnological applications and more! Furnished with helpful references, tables, and drawings, this practical guide is indispensable for pharmaceutical, medicinal, and protein chemists; molecular biologists; process engineers; purification scientists; biopharmaceutical and pharmaceutical formulators and product developers; quality control, quality assurance, and regulatory compliance personnel; and upper-level undergraduate and graduate students in these disciplines.

Providing a well-written and easy-to-read review of the subject, this reference describes the most recent breakthroughs in the validation and execution of testing schemes for parenteral quality control. Emphasize testing methodologies for the evaluation of package integrity, finished product contamination, and sterility, the book is a guide to test

The U.S. Food and Drug Administration (FDA) has approved dozens of hormone therapy products for men and women, including estrogen, progesterone, testosterone, and related compounds. These products have been reviewed for safety and efficacy and are indicated for treatment of symptoms resulting from hormonal changes associated with menopause or other endocrine-based disorders. In recent decades, an increasing number of health care providers and patients have turned to custom-formulated, or compounded, drug preparations as an alternative to FDA-approved drug products for hormone-related health concerns. These compounded hormone preparations are often marketed as "bioidentical" or "natural" and are commonly referred to as compounded bioidentical hormone therapy (cBHT). In light of the fast-growing popularity of cBHT preparations, the clinical utility of these compounded preparations is a substantial public health concern for various stakeholders, including medical practitioners, patients, health advocacy organizations, and federal and state public health agencies. This report examines the clinical utility and uses of cBHT drug preparations and reviews the available evidence that would support marketing claims of the safety and effectiveness of cBHT preparations. It also assesses whether the available evidence suggests that these preparations have clinical utility and safety profiles warranting their clinical use and identifies patient populations that might benefit from cBHT preparations in lieu of FDA-approved BHT.

*Pharmaceutical Quality by Design: Principles and Applications* discusses the Quality by Design (QbD) concept implemented by regulatory agencies to ensure the development of a consistent and high-quality pharmaceutical product that safely provides the maximum therapeutic benefit to patients. The book walks readers through the QbD framework by covering the fundamental principles of QbD, the current regulatory requirements, and the applications of QbD at various stages of pharmaceutical product development, including drug substance and excipient development, analytical development, formulation development, dissolution testing, manufacturing, stability studies, bioequivalence testing, risk and assessment, and clinical trials. Contributions from global leaders in QbD provide specific insight in its application in a diversity of pharmaceutical products, including nanopharmaceuticals, biopharmaceuticals, and vaccines. The inclusion of illustrations, practical examples, and case studies makes this book a useful reference guide to pharmaceutical scientists and researchers who are engaged in the formulation of various delivery systems and the analysis of pharmaceutical product development and drug manufacturing process. Discusses vital QbD precepts and fundamental aspects of QbD implementation in the pharma, biopharma and biotechnology industries Provides helpful illustrations, practical examples and research case studies to explain QbD concepts to readers Includes contributions from global leaders and experts from academia, industry and regulatory agencies

This book describes various methods of decontamination and how the methods work. There is a discussion of the various cleaning and disinfection methods utilized, along with details of how to qualify these methods. It also describes new technologies that may be useful in the battle for decontamination across industries. Finally, this book provides a single resource on how one can address contamination issues for a variety of manufacturing processes and industries. Explores new technologies that may be useful in the battle for decontamination Examines various methods of decontamination and how the methods work Addresses contamination issues for a variety of manufacturing processes and industries Describes how to detect contaminants as well as how to deal with contaminants that are present Includes methods for both decontamination (reaction) and preventing contamination (proactive)

*Principles of Parenteral Solution Validation: A Practical Lifecycle Approach* covers all aspects involved in the development and process validation of a parenteral product. By using a lifecycle approach, this book discusses the latest technology, compliance developments, and regulatory considerations and trends, from process design, to divesting. As part of the *Expertise in Pharmaceutical Process Technology* series edited by Michael Levin, this book incorporates numerous case studies and real-world examples that address timely problems and offer solutions to the daily challenges facing practitioners in this area. Discusses international and domestic regulatory considerations in every section Features callout boxes that contain points-of-interest for each segment of the audience so readers can quickly find their interests and needs Contains important topics, including risk management, the preparation and execution of properly designed studies, scale-up and technology transfer activities, problem-solving, and more

This comprehensive volume discusses approaches for a systematic selection of delivery systems for various classes of therapeutic agents including small molecule, protein, and nucleic acid drugs. Specific topics covered in this book include: Solution, suspension, gel, nanoparticle, microparticle, and implant dosage forms Refillable and microneedle devices Intravitreal, suprachoroidal, intrascleral, transscleral, systemic, and topical routes of delivery Physical methods including iontophoresis for drug delivery Rational selection of routes of administration and delivery systems Noninvasive and continuous drug monitoring Regulatory path to drug product development Clinical endpoints for drug product development Emerging and existing drugs and drug targets Drug Product Development for the Back of the Eye is authored by renowned ocular drug delivery experts, representing academic, clinical, and industrial organizations and serves as indispensable resource for

ophthalmic researchers, drug formulation scientists, drug delivery and drug disposition scientists, as well as clinicians involved in designing and developing novel therapeutics for the back of the eye diseases. This book is also relevant for students in various disciplines including ophthalmology, pharmaceutical sciences, drug delivery, and biomedical engineering. Refillable and microneedle devices Intravitreal, suprachoroidal, intrascleral, transscleral, systemic, and topical routes of delivery Physical methods including iontophoresis for drug delivery Rational selection of routes of administration and delivery systems Noninvasive and continuous drug monitoring Regulatory path to drug product development Clinical endpoints for drug product development Emerging and existing drugs and drug targets Drug Product Development for the Back of the Eye is authored by renowned ocular drug delivery experts, representing academic, clinical, and industrial organizations and serves as indispensable resource for ophthalmic researchers, drug formulation scientists, drug delivery and drug disposition scientists, as well as clinicians involved in designing and developing novel therapeutics for the back of the eye diseases. This book is also relevant for students in various disciplines including ophthalmology, pharmaceutical sciences, drug delivery, and biomedical engineering. Refillable and microneedle devices Intravitreal, suprachoroidal, intrascleral, transscleral, systemic, and topical routes of delivery Physical methods including iontophoresis for drug delivery Rational selection of routes of administration and delivery systems Noninvasive and continuous drug monitoring Regulatory path to drug product development Clinical endpoints for drug product development Emerging and existing drugs and drug targets Drug Product Development for the Back of the Eye is authored by renowned ocular drug delivery experts, representing academic, clinical, and industrial organizations and serves as indispensable resource for ophthalmic researchers, drug formulation scientists, drug delivery and drug disposition scientists, as well as clinicians involved in designing and developing novel therapeutics for the back of the eye diseases. This book is also relevant for students in various disciplines including ophthalmology, pharmaceutical sciences, drug delivery, and biomedical engineering.

Drug Delivery Aspects: Expectations and Realities of Multifunctional Drug Delivery Systems examines the fabrication, optimization, and scale-up of nano and micro carriers. Various aspects like conversion of micro-nano particles into solid dosage form, large scale industry manufacturing challenges of nanocarriers, regulatory considerations on drug device combinations are featured in this volume. Written by a diverse range of international researchers from industry and academia, the chapters examine specific aspects of characterization and manufacturing for pharmaceutical applications as well as regulatory and policy aspects. The Multifunctional Drug Delivery Systems books provide a platform to discuss opportunities and challenges in development of micro-nanomedicine and other drug delivery systems, review industrial manufacturing challenges, discuss current and future market trends, facilitate the insight sharing within various expertise area, and establish collaborations between academic scientists, industrial and clinical researchers. This book connects formulation scientists, regulatory experts, engineers, clinical experts and regulatory stake holders. The wide scope of the book ensures it is a valuable reference resource for researchers in both academia and the pharmaceutical industry who want to learn more about the status of drug delivery systems.

Although the United States (U.S.) and the more developed nations of the remainder of the world are blessed with a variety of pharmaceuticals, feed additives, and biological products to treat, prevent, and control animal diseases, there is a healthy desire among persons involved in animal health issues to increase our animal medicine chest. The interest stems from the desire to efficiently produce food that is safe and plentiful and from the desire to have more and better government-approved products available for the prevention and treatment of diseases of dogs, cats, and horses and for an increasing variety of minor animal species. For the animal health industry, increased drug availability means broader markets, increased revenues, and an opportunity to better serve their customers. For the veterinarian, more animal health products means that he or she is better able to treat the usual and the unusual conditions, and to prevent animal disease and suffering. No doubt, we are all winners when new technology and industrial and regulatory initiatives hasten the availability of safe and effective animal health products.

The successful structure of the previous edition of Principles of Fermentation Technology has been retained in this third edition, which covers the key component parts of a fermentation process including growth kinetics, strain isolation and improvement, inocula development, fermentation media, fermenter design and operation, product recovery, and the environmental impact of processes. This accurate and accessible third edition recognizes the increased importance of animal cell culture, the impact of the post-genomics era on applied science and the huge contribution that heterologous protein production now makes to the success of the pharmaceutical industry. This title is ideally suited for both newcomers to the industry and established workers as it provides essential and fundamental information on fermentation in a methodical, logical fashion. Stanbury, Whitaker and Hall have integrated the biological and engineering aspects of fermentation to make the content accessible to members of both disciplines with a focus on the practical application of theory. This text collates all the fermentation fundamentals into one concise reference, making it a valuable resource for fermentation scientists, as well as those studying in the field. Retains its successful structure and covers all components of the fermentation process Integrates the biological and engineering aspects of fermentation to discuss the most recent developments and advancements in the field Written in a style accessible to readers from either a biological or engineering background with each chapter supported by an extensive bibliography

This comprehensive book encompasses various facets of sterile product development. Key concepts relevant to the successful development of sterile products are illustrated through case studies and are covered under three sections in this book: • Formulation approaches that discuss a variety of dosage forms including protein therapeutics, lipid-based controlled delivery systems, PEGylated biotherapeutics, nasal dosage form, and vaccines • Process, container closure and delivery considerations including freeze-thaw process challenges, best practices for technology transfer to enable commercial product development, innovations and advancement in aseptic fill-finish operations, approaches to manufacturing lyophilized parenteral products, pen / auto-injector delivery devices, and associated container closure integrity testing hurdles for sterile product closures • Regulatory and quality aspects in the areas of particulate matter and appearance evaluation, sterile filtration, admixture compatibility considerations, sterilization process considerations, microbial contamination investigations and validation of rapid microbiological methods, and dry and moist heat sterilizers This book is a useful resource to scientists and researchers in both industry and academia, and it gives process and

product development engineers insight into current industry practices and evolving regulatory expectations for sterile product development.

The Handbook of Pharmaceutical Manufacturing Formulations, Third Edition: Volume Six, Sterile Products is an authoritative and practical guide to the art and science of formulating drugs for commercial manufacturing. With thoroughly revised and expanded content, this sixth volume of a six-volume set, compiles data from FDA and EMA new drug applications, patents and patent applications, and other sources of generic and proprietary formulations including author's own experience, to cover the broad spectrum of cGMP formulations and issues in using these formulations in a commercial setting. A must-have collection for pharmaceutical manufacturers, educational institutions, and regulatory authorities, this is an excellent platform for drug companies to benchmark their products and for generic companies to formulate drugs coming off patent. Features: ? Largest source of authoritative and practical formulations, cGMP compliance guidance and self-audit suggestions ? Differs from other publications on formulation science in that it focuses on readily scalable commercial formulations that can be adopted for cGMP manufacturing ? Tackles common difficulties in formulating drugs and presents details on stability testing, bioequivalence testing, and full compliance with drug product safety elements ? Written by a well-recognized authority on drug and dosage form development including biological drugs and alternative medicines

The suspension dosage form has long been used for poorly soluble active ingredients for various therapeutic indications. Development of stable suspensions over the shelf life of the drug product continues to be a challenge on many fronts. A good understanding of the fundamentals of disperse systems is essential in the development of a suitable pharmaceutical suspension. The development of a suspension dosage form follows a very complicated path. The selection of the proper excipients (surfactants, viscosity imparting agents etc.) is important. The particle size distribution in the finished drug product dosage form is a critical parameter that significantly impacts the bioavailability and pharmacokinetics of the product. Appropriate analytical methodologies and instruments (chromatographs, viscosimeters, particle size analyzers, etc.) must be utilized to properly characterize the suspension formulation. The development process continues with a successful scale-up of the manufacturing process. Regulatory agencies around the world require clinical trials to establish the safety and efficacy of the drug product. All of this development work should culminate into a regulatory filing in accordance with the regulatory guidelines. Pharmaceutical Suspensions, From Formulation Development to Manufacturing, in its organization, follows the development approach used widely in the pharmaceutical industry. The primary focus of this book is on the classical disperse system – poorly soluble active pharmaceutical ingredients suspended in a suitable vehicle.

Sterile Drug Products: Formulation, Packaging, Manufacturing, and Quality teaches the basic principles of the development and manufacture of high quality sterile dosage forms. The author has 38 years of experience in the development and manufacture of sterile dosage forms including solutions, suspensions, ophthalmics and freeze dried products. This book is based on the courses he has delivered for over three decades, to over 3000 participants, and is intended to remain relevant for the indefinite future even as new technologies and new applications of old technologies become common. This is an ideal reference book for those working directly and indirectly with sterile dosage forms, be it product development (formulation, package, process, analytical), manufacturing, quality control, quality assurance, regulatory, purchasing, or project management. This book is also intended as an educational resource for the pharmaceutical and biopharmaceutical industry and pharmacy schools, providing basic knowledge and principles in four main areas of parenteral science and technology: Product development, including formulation, packaging, and process development. Manufacturing, including basic teaching on all the primary unit operations involved in preparation of sterile products and the underlying importance of contamination control. Quality and regulatory, including the application of good manufacturing practice regulations, aseptic processing guidelines, and unique quality control testing methods for the sterile dosage form. Clinical aspects, including administration, potential hazards, and biopharmaceutics of sterile products in a clinical setting.

In this era of biotechnology there have been many books covering the fundamentals of recombinant DNA technology and protein chemistry. However, not many sources are available for the pharmaceutical development scientist and other personnel responsible for the commercialization of the finished dosage forms of these new biopharmaceuticals and other products from biotechnology. This text will help to fill this gap. Once active biopharmaceutical molecules are candidates for clinical trial investigation and subsequent commercialization, a number of other activities must take place while research and development on these molecules continues. The active ingredient itself must be formulated into a finished dosage form that can be conveniently used by health care professionals and patients. Properties of the biopharmaceutical molecule must be clearly understood so that the appropriate finished product formulation can be developed. Finished product formulation development includes not only the chemical formulation, but also the packaging system, the manufacturing process, and appropriate control strategies to assure such good manufacturing practice attributes as safety, identity, strength, purity, and quality.

Sterile Pharmaceutical Products: Process Engineering Applications addresses the key concepts and applications of the sterile pharmaceutical manufacturing industry. It covers elements of the design, installation, validation, and usage of critical processes associated with sterile product manufacture. From water systems to clean-in-place systems, to sterile powder handling and robotic applications in sterile production environments, this book addresses the issues of system implementation, integration, and operations. Written by recognized experts and peer reviewed for accuracy, all chapters include references to supplemental resources and numerous illustrations.

Drug Delivery Systems examines the current state of the field within pharmaceutical science and concisely explains the history of drug delivery systems, including key developments. The book translates the physicochemical properties of drugs into drug delivery systems administered via various routes, such as oral, parenteral, transdermal and inhalational. Regulatory and product development topics are also explored. Written by experts in the field, this volume in the Advances in Pharmaceutical Product Development and Research series deepens

our understanding of drug delivery systems within the pharmaceutical sciences industry and research, as well as in chemical engineering. Each chapter delves into a particular aspect of this fundamental field to cover the principles, methodologies and technologies employed by pharmaceutical scientists. This book provides a comprehensive examination that is suitable for researchers and advanced students working in pharmaceuticals, cosmetics, biotechnologies, and related industries. Provides up-to-date information on how to translate the physicochemical properties of drugs into drug delivery systems Explores how drugs are administered via various routes, such as oral, parenteral, transdermal and inhalational Contains extensive references and further reading for course and self-study Aseptic Processing and Packaging of Food explains how aseptic processing and packaging first began and traces its fascinating progression over the last fifty years. It explores current technologies, discusses why they are used today, and explains why certain basic approaches to critical operations, such as pumping, heat exchange, fluid flow, and controls, must be applied. Commercially used heating and holding concepts are also explained, with emphasis on avoiding problems. This unique book states the technique and method of choice for accurate flow control (timing). It includes an explanation of secondary flow and describes its use to solve many of the heat exchange and fluid flow problems associated with particle-containing products. It also discusses the manufacturers of aseptic packaging equipment, exploring the types of products they produce and the advantages and disadvantages of their product design. Aseptic Processing and Packaging of Food fills in many of the information gaps left by other sources - a must-have reference for anyone working in this area.

Empower your staff to improve safety, quality and compliance with the help of new guidelines and standards. We've updated every chapter of this popular review of the fundamentals of preparing sterile products in hospital, home-care, and community pharmacy settings to reflect the most recent revisions to USP . Included are the latest guidelines for the compounding process, quality assurance methods, and comprehensive coverage of all aspects of the dispensing process. Comprehensive documentation for the guidelines is included in the appendices. Chapters new to this edition focus on: Gap analysis and action plans Safe use of automatic compounding devices Cleaning and disinfecting Radiopharmaceuticals as CSPs Allergen extracts as CSPs.

The biotechnology/biopharmaceutical sector has tremendously grown which led to the invention of engineered antibodies such as Antibody Drug Conjugates (ADCs), Bispecific T-cell engager (BITES), Dual Variable Domain (DVD) antibodies, and fusion proteins that are currently being used as therapeutic agents for immunology, oncology and other disease conditions. Regulatory agencies have raised the bar for the development and manufacture of antibody-based products, expecting to see the use of Quality by Design (QbD) elements demonstrating an in-depth understanding of product and process based on sound science. Drug delivery systems have become an increasingly important part of the therapy and most biopharmaceuticals for self-administration are being marketed as combination products. A survey of the market indicates that there is a strong need for a new book that will provide "one stop shopping" for the latest information and knowledge of the scientific and engineering advances made over the last few years in the area of biopharmaceutical product development. The new book entitled Development of Biopharmaceutical Drug Device Products is a reference text for scientists and engineers in the biopharmaceutical industry, academia or regulatory agencies. With insightful chapters from experts in the field, this new book reviews first principles, covers recent technological advancements and provides case studies and regulatory strategies relating to the development and manufacture of antibody-based products. It covers topics such as the importance of early preformulation studies during drug discovery to influence molecular selection for development, formulation strategies for new modalities, and the analytical techniques used to characterize them. It also addresses important considerations for later stage development such as the development of robust formulations and processes, including process engineering and modeling of manufacturing unit operations, the design of analytical comparability studies, and characterization of primary containers (pre-filled syringes and vials). Finally, the latter half of the book reviews key considerations to ensure the development and approval of a patient-centered delivery system design. This involves the evolving regulatory framework with perspectives from both the US and EU industry experts, the role of international standards, design control/risk management, human factors and its importance in the product development and regulatory approval process, as well as review of the risk-based approach to bridging between devices used in clinical trials and the to-be-marketed device. Finally, case studies are provided throughout. The typical readership would have biology and/or engineering degrees and would include researchers, scientific leaders, industry specialists and technology developers working in the biopharmaceutical field.

This volume explores the application of Quality by Design (QbD) to biopharmaceutical drug product development. Twenty-eight comprehensive chapters cover dosage forms, liquid and lyophilized drug products. The introductory chapters of this book define key elements of QbD and examine how these elements are integrated into drug product development. These chapters also discuss lessons learned from the FDA Office of Biotechnology Products pilot program. Following chapters demonstrate how QbD is used for formulation development ranging from screening of formulations to developability assessment to development of lyophilized and liquid formats. The next few chapters study the use of small-scale and surrogate models as well as QbD application to drug product processes such as drug substance freezing and thawing, mixing, sterile filtration, filling, lyophilization, inspection and shipping and handling. Later chapters describe more specialized applications of QbD in the drug product realm. This includes the use of QbD in primary containers, devices and combination product development. The volume also explores QbD applied to vaccine development, automation, mathematical modeling and monitoring, and controlling processes and defining control strategies. It concludes with a discussion on the application of QbD to drug product technology transfer as well as overall regulatory considerations and lifecycle management. Quality by Design for Biopharmaceutical Drug Product Development is an authoritative resource for scientists and researchers interested in expanding their knowledge on QbD principles and uses in creating better drugs.

Practical Aspects of Vaccine Development provides an academic and industry perspective on vaccine development and manufacturing. With the increasing complexity of vaccine products in development, there is a need for a comprehensive review of the current state of the industry and challenges being encountered. While formulation scientists working in biotherapeutic development may be familiar with proteins, vaccines present unique challenges. Vaccines include a wide range of components including proteins, polysaccharides, protein-polysaccharide conjugates, adjuvants, and more. The container closure system may also be unique, and the product may require freezing storage or lyophilization based on the stability of the vaccine components. Based on the route of delivery, novel technologies and devices may be required. Covering formulation development, manufacture, and delivery considerations of vaccine production, this book is essential to formulation scientists, researchers in vaccine development throughout medical and life sciences, and advanced students. Includes formulation considerations for various vaccine types, including proteins, polysaccharides, conjugates, and live vaccines Covers process development for solution, suspension, and lyophilized products Explores the future of vaccines, including multi-component vaccines and novel delivery mechanisms/devices

This book surveys the field of long acting injections and implants, which improve therapy, enhance patient compliance, and enhance dosing convenience. Topics include the historical development of drugs and diseases, and clinical applications for long acting injections and implants.

The preparation of sterile products using aseptic processing is considered perhaps the most critical process in the pharmaceutical industry and has witnessed continual improvement over the last half century. New approaches that have transformed classical aseptic production methods are appearing almost daily. This book reviews emerging technologies for aseptic processing that will markedly reduce the level of contamination risk for sterile products and includes coverage on: The use of isolator and barrier

concepts for aseptic processing and assembly. The application of robotics as an alternative to gowned personnel. The increasing reliance on automation to minimize or eliminate operator intervention. The design, operational, monitoring and compliance changes necessary for success with advanced aseptic processing. Advanced Aseptic Processing Technology is an essential reference for anyone working with sterile products, and is recommended for individuals in manufacturing, compliance, regulatory affairs, microbiology, environmental monitoring, sterility testing, sterilization, validation, engineering, development, facility and equipment design, component and equipment suppliers, automation, and robotics.

This handbook features contributions from a team of expert authors representing the many disciplines within science, engineering, and technology that are involved in pharmaceutical manufacturing. They provide the information and tools you need to design, implement, operate, and troubleshoot a pharmaceutical manufacturing system. The editor, with more than thirty years' experience working with pharmaceutical and biotechnology companies, carefully reviewed all the chapters to ensure that each one is thorough, accurate, and clear.

The use of modeling and simulation tools is rapidly gaining prominence in the pharmaceutical industry covering a wide range of applications. This book focuses on modeling and simulation tools as they pertain to drug product manufacturing processes, although similar principles and tools may apply to many other areas. Modeling tools can improve fundamental process understanding and provide valuable insights into the manufacturing processes, which can result in significant process improvements and cost savings. With FDA mandating the use of Quality by Design (QbD) principles during manufacturing, reliable modeling techniques can help to alleviate the costs associated with such efforts, and be used to create in silico formulation and process design space. This book is geared toward detailing modeling techniques that are utilized for the various unit operations during drug product manufacturing. By way of examples that include case studies, various modeling principles are explained for the nonexpert end users. A discussion on the role of modeling in quality risk management for manufacturing and application of modeling for continuous manufacturing and biologics is also included. Explains the commonly used modeling and simulation tools Details the modeling of various unit operations commonly utilized in solid dosage drug product manufacturing Practical examples of the application of modeling tools through case studies Discussion of modeling techniques used for a risk-based approach to regulatory filings Explores the usage of modeling in upcoming areas such as continuous manufacturing and biologics

Bullet points

Knowing how to deal with the regulatory issues, understanding the impacts of cleanliness, and recognizing the affect that poor facility layout will have on GMP spaces are only some of the issues an experienced Project Manager must focus on. Completely revised and updated, *Sterile Product Facility Design and Project Management, Second Edition* provides comprehensive guidance on how to develop and execute biotech and other sterile drug facilities based on current industry best practices. Each chapter highlights a specific issue centered on managing biotech facilities projects in a GMP environment. The author uses real-world examples of common industry practice to lead you through the idiosyncrasies of a biotech project in an effort to answer some of the more common, and often perplexing, questions that can stand in the way of success. You get a mini seminar on each topic covered. Breaking the project life-cycle into four phases, the text takes you through each phase from the Project Manager's viewpoint. Unlike other books that cover design, technology, and validation in general terms, this book addresses the industry specific issues that make biotech facilities so costly and difficult to deliver. It puts the pieces of the puzzle together in a manner that increases your opportunity for success.

*The Future of Pharmaceutical Product Development and Research* examines the latest developments in the pharmaceutical sciences, also highlighting key developments, research and future opportunities. Written by experts in the field, this volume in the *Advances in Pharmaceutical Product Development and Research* series deepens our understanding of the product development phase of drug discovery and drug development. Each chapter covers fundamental principles, advanced methodologies and technologies employed by pharmaceutical scientists, researchers and the pharmaceutical industry. The book focuses on excipients, radiopharmaceuticals, and how manufacturing should be conducted in an environment that follows Good Manufacturing Practice (GMP) guidelines. Researchers and students will find this book to be a comprehensive resource for those working in, and studying, pharmaceuticals, cosmetics, biotechnology, foods and related industries. Provides an overview of practical information for clinical trials Outlines how to ensure an environment that follows Good Manufacturing Practice (GMP) Examines recent developments and suggests future directions for drug production methods and techniques

Due to a worldwide need for lower cost drug therapy, use of generic and multi-source drug products have been increasing. To meet international patent and trade agreements, the development and sale of these products must conform to national and international laws, and generic products must prove that they are of the same quality and are therapeutically equivalent to the brand name alternative. However, many countries have limited resources to inspect and verify the quality of all drug products for sale in their country. This title discusses the worldwide legislative and regulatory requirements for the registration of generic and multi-source drug products.

A range of new and innovative tools used for preformulation and formulation of medicines help optimize pharmaceutical development projects. Such tools also assist with the performance evaluation of the pharmaceutical process, allowing any potential gaps to be identified. These tools can be applied in both basic research and industrial environment. Formulation tools for pharmaceutical development considers these key research and industrial tools. Nine chapters by leading contributors cover: Artificial neural networks technology to model, understand, and optimize drug formulations; ME\_expert 2.0: a heuristic decision support system for microemulsions formulation development; Expert system for the development and formulation of push-pull osmotic pump tablets containing poorly water-soluble drugs; SeDeM Diagram: an expert system for preformulation, characterization and optimization of tables obtained by direct compression; New SeDeM-ODT expert system: an expert system for formulation of orodispersible tablets obtained by direct compression; and 3D-cellular automata in computer-aided design of pharmaceutical formulations: mathematical concept and F-CAD software. Coverage of artificial intelligence tools, new expert systems, understanding of pharmaceutical processes, robust development of medicines, and new ways to develop medicines Development of drugs and medicines using mathematical tools Compilation of expert system developed around the world *Pharmaceutical Preformulation and Formulation: A Practical Guide* from Candidate Drug Selection to Commercial Dosage Form reflects the mounting pressure on pharmaceutical companies to accelerate the new drug development and launch process, as well as the shift from developing small molecules to the growth of biopharmaceuticals. The book meets the need for advanced information for drug preformulation and formulation and addresses the current trends in the continually evolving pharmaceutical

industry. Topics include: Candidate drug selection Drug discovery and development Preformulation predictions and drug selections Product design to commercial dosage form Biopharmaceutical support in formulation Development The book is ideal for practitioners working in the pharmaceutical arena—including R&D scientists, technicians, and managers—as well as for undergraduate and postgraduate courses in industrial pharmacy and pharmaceutical technology.

**Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes** covers bioprocessing from cell line development to bulk drug substances. The methods and strategies described are essential learning for every scientist, engineer or manager in the biopharmaceutical and vaccines industry. The integrity of the bioprocess ultimately determines the quality of the product in the biotherapeutics arena, and this book covers every stage including all technologies related to downstream purification and upstream processing fields. Economic considerations are included throughout, with recommendations for lowering costs and improving efficiencies. Designed for quick reference and easy accessibility of facts, calculations and guidelines, this book is an essential tool for industrial scientists and managers in the biopharmaceutical industry. Offers a comprehensive, go-to reference for daily work decisions Covers both upstream and downstream processes Includes case studies that emphasize financial outcomes Presents summaries, decision grids, graphs and overviews for quick reference

When a pharmaceutical company decides to build a Quality System, it has to face the fact that there aren't any guideline that define exactly how such a system has to be built. With terms such as quality system, quality assurance, and quality management used interchangeably, even defining the system's objectives is a problem. This book provides a pr

**Parenteral Medications** is an authoritative, comprehensive reference work on the formulation and manufacturing of parenteral dosage forms, effectively balancing theoretical considerations with practical aspects of their development. Previously published as a three-volume set, all volumes have been combined into one comprehensive publication that addresses the plethora of changes in the science and considerable advances in the technology associated with these products and routes of administration. Key

Features: Provides a comprehensive reference work on the formulation and manufacturing of parenteral dosage forms Addresses changes in the science and advances in the technology associated with parenteral medications and routes of administration

Includes 13 new chapters and updated chapters throughout Contains the contributors of leading researchers in the field of parenteral medications Uses full color detailed illustrations, enhancing the learning process The fourth edition not only reflects enhanced content in all the chapters but also highlights the rapidly advancing formulation, processing, manufacturing parenteral technology including advanced delivery and cell therapies. The book is divided into seven sections: Section 1 - Parenteral Drug Administration and Delivery Devices; Section 2 - Formulation Design and Development; Section 3 - Specialized Drug Delivery Systems; Section 4 - Primary Packaging and Container Closure Integrity; Section 5 - Facility Design and Environmental Control; Section 6 - Sterilization and Pharmaceutical Processing; Section 7 - Quality Testing and Regulatory Requirements

A needed resource for pharmaceutical scientists and cosmetic chemists, **Essential Chemistry for Formulators of Semisolid and Liquid Dosages** provides insight into the basic chemistry of mixing different phases and test methods for the stability study of nonsolid formulations. The book covers foundational surface/colloid chemistry, which forms the necessary background for making emulsions, suspensions, solutions, and nano drug delivery systems, and the chemistry of mixing, which is critical for further formulation of drug delivery systems into semisolid (gels, creams, lotions, and ointments) or liquid final dosages. Expanding on these foundational principles, this useful guide explores stability testing methods, such as particle size, rheological/viscosity, microscopy, and chemical, and closes with a valuable discussion of regulatory issues. **Essential Chemistry for Formulators of Semisolid and Liquid Dosages** offers scientists and students the foundation and practical guidance to make and analyze semisolid and liquid formulations. Unique coverage of the underlying chemistry that makes possible stable dosages Quality content written by experienced experts from the drug development industry Valuable information for academic and industrial scientists developing topical and liquid dosage formulations for pharmaceutical as well as skin care and cosmetic products

This book provides comprehensive information of the nanotechnology-based pharmaceutical product development including a diverse range of arenas such as liposomes, nanoparticles, fullerenes, hydrogels, thermally responsive externally activated theranostics (TREAT), hydrogels, microspheres, micro- and nanoemulsions and carbon nanomaterials. It covers the micro- and nanotechnological aspects for pharmaceutical product development with the product development point of view and also covers the industrial aspects, novel technologies, stability studies, validation, safety and toxicity profiles, regulatory perspectives, scale-up technologies and fundamental concept in the development of products. Salient Features: Covers micro- and nanotechnology approaches with current trends with safety and efficacy in product development. Presents an overview of the recent progress of stability testing, reverse engineering, validation and regulatory perspectives as per regulatory requirements. Provides a comprehensive overview of the latest research related to micro- and nanotechnologies including designing, optimisation, validation and scale-up of micro- and nanotechnologies. Is edited by two well-known researchers by contribution of vivid chapters from renowned scientists across the globe in the field of pharmaceutical sciences. Dr. Neelesh Kumar Mehra is working as an Assistant Professor of Pharmaceutics & Biopharmaceutics at the Department of Pharmaceutics, National Institute of Pharmaceutical Education & Research (NIPER), Hyderabad, India. He received 'TEAM AWARD' for successful commercialisation of an ophthalmic suspension product. He has authored more than 60 peer-reviewed publications in highly reputed international journals and more than 10 book chapter contributions. He has filed patents on manufacturing process and composition to improved therapeutic efficacy for topical delivery. He guided PhD and MS students for their dissertations/research projects. He has received numerous outstanding awards including Young Scientist Award and Team Award for his research output. He recently published one edited book, 'Dendrimers in Nanomedicine: Concept, Theory and Regulatory Perspectives', in CRC Press. Currently, he is editing books on nano drug delivery-based products with Elsevier Pvt Ltd. He has rich research and teaching experience in the formulation and development of complex, innovative ophthalmic and injectable biopharmaceutical products including micro- and nanotechnologies for regulated market. Dr. Arvind Gulbake is working as an Assistant Professor at the Faculty of Pharmacy, School of Pharmaceutical & Population Health Informatics, at DIT University, Dehradun, India. He has authored more than 40 peer-reviewed publications in highly reputed international journals, four book chapters and a patent contribution. He has received outstanding awards including Young Scientist Award and BRG Travel Award for his research. He is an assistant editor for IJAP. He guided PhD and MS students for their dissertations/research projects. He has successfully completed extramural project funded by SERB, New Delhi, Government of India. He has more than 12 years of research and teaching experience in the formulation and development of nanopharmaceuticals.

**Specification of Drug Substances and Products: Development and Validation of Analytical Methods, Second Edition**, presents a

comprehensive and critical analysis of the requirements and approaches to setting specifications for new pharmaceutical products, with an emphasis on phase-appropriate development, validation of analytical methods, and their application in practice. This thoroughly revised second edition covers topics not covered or not substantially covered in the first edition, including method development and validation in the clinical phase, method transfer, process analytical technology, analytical life cycle management, special challenges with generic drugs, genotoxic impurities, topical products, nasal sprays and inhalation products, and biotechnology products. The book's authors have been carefully selected as former members of the ICH Expert Working Groups charged with developing the ICH guidelines, and/or subject-matter experts in the industry, academia and in government laboratories. Presents a critical assessment of the application of ICH guidelines on method validation and specification setting  
Written by subject-matter experts involved in the development and application of the guidelines Provides a comprehensive treatment of the analytical methodologies used in the analysis, control and specification of new drug substances and products  
Covers the latest statistical approaches (including analytical quality by design) in the development of specifications, method validation and shelf-life prediction

“Biobetters: Protein Engineering to Approach the Curative” discusses the optimization of protein therapeutic products for treatment of human diseases. It is based on the fact that though numerous important therapeutic protein products have been developed for life threatening and chronic diseases that possess acceptable safety and efficacy profiles, these products have generally not been reexamined and modified for an improved clinical performance, with enhancements both to safety and efficacy profiles. Advances in protein engineering, coupled with greatly enhanced understanding of critical product quality attributes for efficacy and safety, make it possible to optimize predecessor products for clinical performance, thereby enhancing patient quality of life and with the potential for great savings in health care costs. Yet despite such knowledge, there is little movement towards such modifications. This book examines engineering protein therapeutic products such that they exhibit an optimal, not just an adequate, clinical performance profile. Two product classes, therapeutic enzymes for lysosomal storage diseases (enzyme replacement therapies, ERT) and monoclonal antibodies (mAbs), are used as examples of what modifications to such proteins could be made to enhance clinical performance, “closer to a cure” as it were. For ERT, the key to optimizing clinical performance is to ensure the ERT is endowed with moieties that target the protein to the relevant target tissue. Thus, for Gaucher Disease, our best example of how to optimize an ERT to address a disease that manifests in specific target tissues (macrophages and monocytes), the enzyme has been extensively modified to target macrophages. For diseases such as Pompe Disease, largely a disorder of muscle, optimal performance of ERT will depend on endowing the enzyme with the ability to be taken up via the Mannose 6 Phosphate Receptor, and so one of the chapters in the book will discuss such approaches. Moreover, a major failure of biotechnology based products is to gain access to the CNS, a key target tissue in numerous diseases. Thus, a chapter has been devoted to strategies to access the CNS. Additionally, immune responses to therapeutic proteins can be highly problematic, eliminating the efficacy of life saving or highly effective protein therapeutics. This is especially poignant in the case of Pompe Disease wherein great improvement in muscle strength and functionality is lost following development of an immune response to the ERT with consequent patient deterioration and death. Thus, a chapter regarding protein engineering, as well as other non-clinical approaches to diminishing immunogenicity is a valuable part of the book. Monoclonal antibodies (mAbs) can be engineered to bind targets relevant to a wide variety of diseases; binding affinity, however, is only part of the equation and one of the chapters will present a molecular assessment approach that balances affinity with pharmacokinetics and manufacturability. As with other proteins immunogenicity can be problematic, being responsible for loss of efficacy of anti-TNF mAbs, often after prolonged successful treatment. The authors will also share their perspective on the consequences of physico-chemical modifications occurring to mAbs once they reach the circulation or their target, a research area open to further development from a protein engineering as well as analytical perspective. This book will also discuss novel platforms for protein therapeutics, technologies that exceed mAbs with respect to potency, and hence, potentially efficacy. These platforms consist largely of repeat domain proteins with very high affinity for their target ligands, but while potentially more efficacious, immunogenicity may be a major problem limiting use. The economics surrounding the issue of biobetters is another high-profile issue - this final chapter will explore the incentives and disincentives for developing biobetters and consider incentives that might make their pursuit more rewarding.

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