e-ISSN: 2347–7857
p-ISSN: 2347-7849

Research and Reviews: Journal of Pharmaceutics and Nanotechnology

Pharmaceutical Nanotechnology - Applications of Nanotechnology in Pharmaceutics

Pratibha Muntha*

Department of Pharmaceutics, Vignan Institute of pharmaceutical Sciences, Jawaharlal Nehru technological University, Deshmukhi, Nalgonda, Telangana, India

Research Article

Received: 02/08/2016
Accepted: 05/08/2016
Published: 12/08/2016

***For Correspondence**

Pratibha Muntha, Department of Pharmaceutics, Vignan Institute of pharmaceutical Sciences, Jawaharlal Nehru technological University, Deshmukhi, Nalgonda Telangana, India
E-mail:
pratibha.muntha@gmail.com

Keywords: Nanotechnology, Drug development, Pharmaceutics, Pharmaceutical nanotechnology

ABSTRACT

Nanotechnology deals with the study of smaller structures with a size range between 0.1 to 100 nm. It covers various areas like biophysics, molecular biology, and bioengineering and sub specialties of medicine such as cardiology, ophthalmology, endocrinology, oncology, immunology etc...

Pharmaceutical Nanotechnology applies the methods and principles of Nano science and nano medicine to pharmacy to develop new drug delivery systems which can overcome the drawbacks of conventional drug delivery systems.

INTRODUCTION

Nanotechnology is the study of very small structures. Pharmaceutical Nanotechnology deals with the formation and development of small structures like atoms, molecules or compounds of size 0.1 to 100 nm into structures which can be further developed into special devices with desired characteristics and properties [1].

Application of nanotechnology into pharmaceutics helps in the formulation of more advanced drug delivery systems and so it is an important and powerful tool as an alternative to conventional dosage form. Pharmaceutical nanotechnology is a specialized field which will change the fate of the pharmaceutical industry in near future. Pharmaceutical nanotechnology helps to fight against several diseases by detecting the antigen associated with diseases and also by detecting the microorganisms and viruses causing the diseases [2-5].

Pharmaceutical Nanotechnology has played a very key role to overcome several drawbacks of conventional dosage forms for like tablets, capsules etc. The conventional forms suffered with drawbacks like low bioavailability, poor patient compliance, damage to healthy cells etc. which were rectified using pharmaceutical nanotechnology [6-10].

PHARMACEUTICAL NANO SYSTEMS

a) **Polymeric Nanoparticles**: They have a size range of 10-1000 nm and are Biocompatible and biodegradable providing complete drug protection. Polymeric nanoparticles are used as carriers for controlled and sustained delivery of drugs [11,12].

b) **Dendrimers**: Dendrimers have a size of <10 nm and are produced by controlled polymerization. These are highly branched mono disperse polymeric systems. Dendrimers are used for controlled delivery of drugs and for targeted delivery of drugs to macrophages and liver [13-15].

c) **Metallic nanoparticles**: Metallic nanoparticles are gold and silver colloids having a size of <100 nm. They are very small in size resulting in more surface area and have more bioavailability and stability which is ideal characterizes of a drug. These are used for drug and gene delivery and are used in sensitive diagnostic assays, thermal ablation and radiotherapy enhancement [16-20].

e-ISSN: 2347–7857
p-ISSN: 2347-7849

d) **Polymeric micelles**: They have a size range of 10-100 nm with high drug entrapment nature and bio stability. These are of high diagnostic vatu and are used for active and passive targeted drug delivery [21].
e) **Liposomes**: These are phospholipid vesicles with a size range of 50-100 nm with features of good biocompatibility and entrapment efficiency. These are used for passive and active delivery of gene, protein and peptides [22-45].
The various systems under nanotechnology are shown in **Figure 1**.

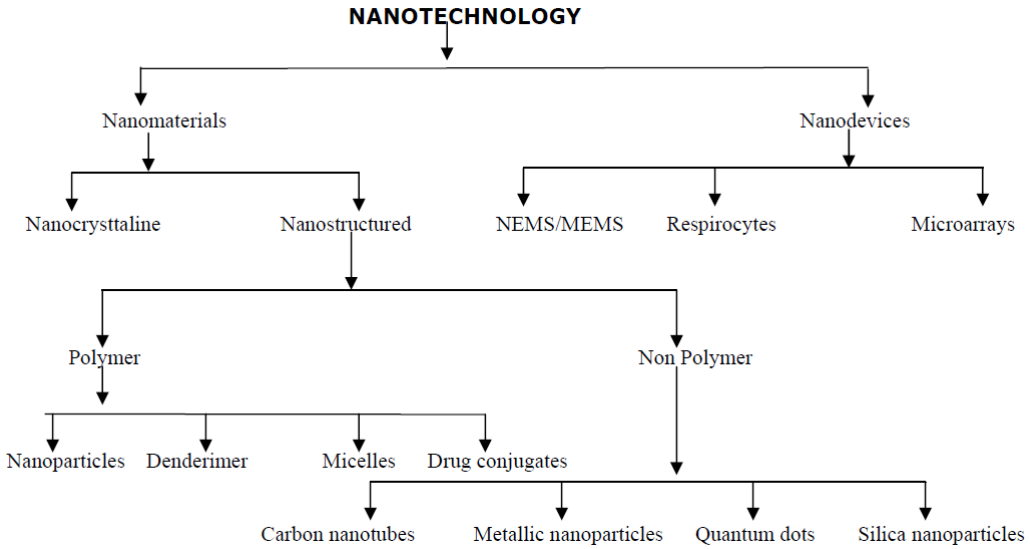

Figure 1: Different systems in nanotechnology.

The various dimensions of particles in Nanotechnology are shown in **Figure 2**.

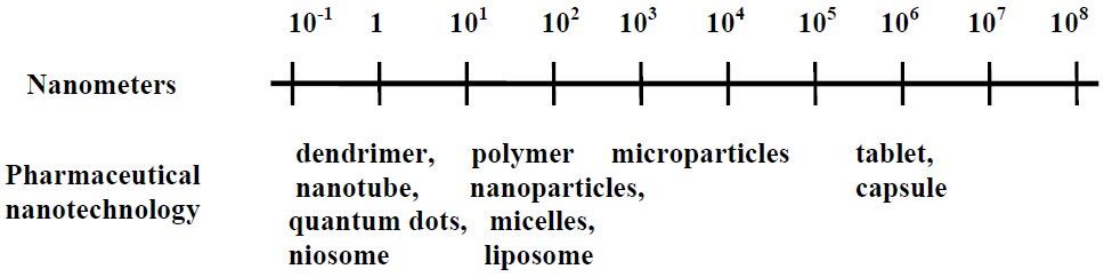

Figure 2: Particles and their dimensions in nanotechnology.

PHARMACEUTICAL NANO MATERIALS

The various materials which play an important role in pharmaceutical nanotechnology are:
Nano materials: These are the biomaterials which are used for surface modifications or coatings helping in enhancing the biocompatibility and bioavailability of various other materials [46-70].
Nano crystalline materials: These are manufactured to act as substitutes for the materials which have poor characteristics like bioavailability, solubility, etc [71-85].
Nanostructured materials: These are the processed forms with special shapes and functionality some of which include nano- and micro-electromechanical systems, microfluidics and microarrays [86-100].

APPLICATIONS OF PHARMACEUTICAL NANOTECHNOLOGY

a) Drug delivery systems: Conventional drug delivery systems have various limitations of lack of specificity, greater rate of drug metabolism, cytotoxicity, high dose requirement, poor patient compliance etc...and these can be overcome by drug delivery systems formulated using the principles in pharmaceutical nanotechnology
b) **Diagnosis**: Molecular imaging is the science of characterizing, and quantifying biological processes in organisms which include gene expression, protein-protein interaction, signal transduction, cellular metabolism and both intracellular and intercellular trafficking.

c) **Drug discovery**: Pharmaceutical nanotechnology plays an important role in drug discovery and development as it helps in the improving the characteristics such as solubility, bioavailability, etc…of the potent drugs and excipients etc.

CONCLUSION

Pharmaceutical nanotechnology has a new scope of study with better opportunities in different areas of diagnosis and treatment. Pharmaceutical nanotechnology has developed as a new area of interest having a great potential as carrier for many potent drugs and diagnostics. It is well-established as a specialized area for drug delivery, diagnostics, prognostic and treatment of diseases through its nano engineered tools. It provides opportunity to improve materials, medical devices and help to develop new technologies and overcome the limitations of conventional techniques.

REFERENCES

1. Fadel M, et al. Antitumor Efficiency of Doxorubicin Loaded in Liposomes and Poly Ethylene Glycol Coated Ferrofluid Nanoparticles. J Nanomater Mol Nanotechnol. 2015;4:1
2. Usta A and Asmatulu R. Synthesis and Analysis of Electrically Sensitive Hydrogels Incorporated with Cancer Drugs. J Pharm Drug Deliv Res. 2016;5:2.
3. Král V, et al. Multifunctional Bile Acid Derivatives as Efficient RNA Transporters (Carriers). J Pharm Drug Deliv Res. 2016;5:2.
4. Panchangam RBS and Dutta T. Engineered Nanoparticles for the Delivery of Anticancer Therapeutics. J Pharm Drug Deliv Res. 2015;4:1.
5. Adesina SK, et al. Nanoparticle Characteristics Affecting Efficacy. J Pharm Drug Deliv Res. 2016;5:1.
6. Olaso I, et al. A Comparative Study of the Treatment of Giardiasis with Commercially Marketed Medicine, Metronidazol with Compounding Medicine at a Rural Hospital in Ethiopia. J Pharm Drug Deliv Res. 2016;5:2.
7. Hasegawa H, et al. Sitagliptin Inhibits the Lipopolysaccharide-Induced Inflammation. J Pharm Drug Deliv Res. 2016;5:2.
8. Král V, et al. Multifunctional Bile Acid Derivatives as Efficient RNA Transporters (Carriers). J Pharm Drug Deliv Res. 2016;5:2.
9. Abdou EM and Ahmed NM. Terconazole Proniosomal Gels: Effect of Different Formulation Factors, Physicochemical and Microbiological Evaluation. J Pharm Drug Deliv Res. 2016;5:1.
10. Strehlow B, et al. A Novel Microparticulate Formulation with Allicin In Situ Synthesis. J Pharm Drug Deliv Res. 2016;5:1.
11. Parteni O, et al. The Release of Tacrolimus from a Cotton Biomaterial to Dermis. J Pharm Drug Deliv Res. 2016;5:1.
12. Orji JI, et al. Physicochemical Properties of Co-Precipitate of Plantain Peel Cellulose and Gelatin. J Pharm Drug Deliv Res. 2015;4:4.
13. Solomon AO, et al. Making Drugs Safer: Improving Drug Delivery and Reducing Side-Effect of Drugs on the Human Biochemical System. J Pharm Drug Deliv Res. 2015;4:4.
14. Ellison TT, et al. Intra-Operative Computed Tomography Confirmation of Intrathecal Drug Delivery System Catheter. J Spine Neurosurg. 2015;4:5.
15. Ferreira H, et al. Deformable Liposomes for the Transdermal Delivery of Piroxicam. J Pharm Drug Deliv Res 2015;4:4.
16. Joshi RR and Devarajan PV. Anionic Self Micro-Emulsifying Drug Delivery System (SMEDDS) Of Docetaxel for Circulation Longevity. J Pharm Drug Deliv Res. 2015;4:3.
17. Nair AK, et al. Development and Comparative Assessment of Hydrocolloid Based Against Wax Based Gastro Retentive Bilayered Floating Tablet Designs of Atorvastatin Calcium Using Qbd Approach. J Pharm Drug Deliv Res. 2015;4:3.

18. Wiley TS, et al. (2015) H1R Antagonists for Brain Inflammation and Anxiety: Targeted Treatment for Autism Spectrum Disorders. J Pharm Drug Deliv Res. 2015;4:3.
19. Mahipalreddy D, et al. Preparation and Evaluation of Ketoprofen Enteric Coated Mini Tablets for Prevention of Chronic Inflammatory Disease. J Pharm Drug Deliv Res. 2015;4:2.
20. Radu CD, et al. Comparative Study of a Drug Release from a Textile to Skin. J Pharm Drug Deliv Res. 2015;4:2.
21. Satyavathi K, et al. Formulation and In-Vitro Evaluation of Liposomal Drug Delivery System of Cabazitaxel. J Pharm Drug Deliv Res. 2015;4:2.
22. Lokesh BVS and Kumar PV. Enhanced Cytotoxic Effect of Chemically Conjugated Polymeric Sirolimus against HT-29 Colon Cancer and A-549 Lung Cancer Cell Lines. J Pharm Drug Deliv Res. 2015;4:2.
23. Bassani AS, et al. In Vitro Characterization of the Percutaneous Absorption of Lorazepam into Human Cadaver Torso Skin, Using the Franz Skin Finite Dose Model. J Pharm Drug Deliv Res. 2015;4:2.
24. Koteswari P, et al. Fabrication of a Novel Device Containing Famotidine for Gastro Retentive Delivery Using Carbohydrate Polymers. J Pharm Drug Deliv Res. 2015;4:1.
25. Brijesh KV, et al. Physicochemical Characterization and In-Vitro Dissolution Enhancement of Bicalutamide-Hp-B-Cd Complex. J Pharm Drug Deliv Res. 2015;3:2.
26. Coyne CP and Narayanan L. Fludarabine-(C2-methylhydroxyphosphoramide)-[anti-IGF-1R]: Synthesis and Selectively "Targeted" Anti-Neoplastic Cytotoxicity against Pulmonary Adenocarcinoma (A549). J Pharm Drug Deliv Res. 2015;4:1.
27. Kaliappan I, et al. Structural Elucidation of Possible Metabolic Profile of Mangiferin by Oral and Intraperitoneal Administration. J Pharm Drug Deliv Res. 2015;4:1.
28. Panchangam RBS and Dutta T. Engineered Nanoparticles for the Delivery of Anticancer Therapeutics. J Pharm Drug Deliv Res. 2015;4:1.
29. Ranjna CD, et al. Inhibiting Human Lactate Dehydrogenase-C for Male Fertility Control; Initial Hits. J Pharm Drug Deliv Res. 2014;3:2.
30. Humayoon R, et al. Quality Control Testing and Equivalence of Doxycycline Hyclate (100 mg) Capsule Brands under Biowaiver Conditions. J Pharm Drug Deliv Res. 2014;3:2.
31. Efentakis M and Siamidi A. Design and Evaluation of a Multi-Layer Tablet System Based on Dextran. J Pharm Drug Deliv Res. 2014;3:2.
32. Dey B, et al. Comparative Evaluation of Hypoglycemic Potentials of Eucalyptus Spp. Leaf Extracts and their Encapsulations for Controlled Delivery. J Pharm Drug Deliv Res. 2014;3:2.
33. Chopra AK, et al. Box-Behnken Designed Fluconazole Loaded Chitosan Nanoparticles for Ocular Delivery. J Pharm Drug Deliv Res. 2014;3:1.
34. Ogaji IJ, et al. Some Characteristics of Theophylline Tablets Coated with Samples of Grewia Gum obtained from a Novel Extraction. J Pharm Drug Deliv Res. 2014;3:1.
35. Kumar R and Lal S. Synthesis of Organic Nanoparticles and their Applications in Drug Delivery and Food Nanotechnology: A Review. J Nanomater Mol Nanotechnol. 2014;3:4.
36. Gunjan J and Swarnlata S. Topical Delivery of Curcuma Longa Extract Loaded Nanosized Ethosomes to Combat Facial Wrinkles. J Pharm Drug Deliv Res. 2014;3:1.
37. Mohamed Idrees RY and Khalid A. Comparative Modeling of Serotonin Receptors 5ht2a and 5ht2c and In-silico Investigation of their Potential as Off-Target to Ethinylestradiol. J Pharm Drug Deliv Res. 2013;2:2.
38. Scott D and Bae Y. Block Copolymer Crosslinked Nanoassemblies Co-entrapping Hydrophobic Drugs and Lipophilic Polymer Additives. J Pharm Drug Deliv Res. 2013;2:2.
39. Satya Krishna HP, et al. Solubility and Dissolution Enhancement of Candesartan Cilexetil by Liquisolid Compacts. J Pharm Drug Deliv Res. 2013;2:2.
40. Isabel S and Paula G. Encapsulation of Fluoroquinolones in 1-Palmitoyl-2-Myristoyl-Phosphatidylcholine: Cholesterol Liposomes. J Pharm Drug Deliv Res. 2013;2:1.

41. Akash MSH, et al. Characterization of Ethylcellulose and Hydroxypropyl Methylcellulose Microspheres for Controlled Release of Flurbiprofen. J Pharm Drug Deliv Res. 2013;2:1.
42. Frank T. Population Pharmacokinetics of Lixisenatide, a Once-Daily Human Glucagon-Like Peptide-1 Receptor Agonist, in Healthy Subjects and in Patients with Type 2 Diabetes. J Pharm Drug Deliv Res. 2013;2:1.
43. ElShaer A, et al. Preparation and Evaluation of Amino Acid Based Salt Forms of Model Zwitterionic Drug Ciprofloxacin. J Pharm Drug Deliv Res. 2013;2:1.
44. Zhou Y, et al. Therapeutic Effects of Sinomenine Microemulsion-Based Hydrogel on Adjuvant-Induced Arthritis in Rats. J Pharm Drug Deliv Res. 2012;1:3.
45. Sharma B, et al. Formulation, Optimization and Evaluation of Atorvastatin Calcium Loaded Microemulsion. J Pharm Drug Deliv Res. 2012;1:3.
46. Ibtehal S, et al. Preparation of Zaleplon Microparticles Using Emulsion Solvent Diffusion Technique. J Pharm Drug Deliv Res. 2012;1:3.
47. Farrell K and Kothapalli CR. Tissue Engineering Approaches for Motor Neuron Pathway Regeneration. J Regen Med. 2012;1:2.
48. D'Cruz OJ and Uckun FM. Targeting Spleen Tyrosine Kinase (SYK) for Treatment of Human Disease. J Pharm Drug Deliv Res. 2012;1:2.
49. Al-Malah KI. Prediction of Aqueous Solubility of Organic Solvents as a Function of Selected Molecular Properties. J Pharm Drug Deliv Res. 2012;1:2.
50. Akintunde JK, et al. Sub-Chronic Treatment of Sildernafil Citrate (Viagra) on some Enzymatic and Non-enzymatic Antioxidants in Testes and Brain of Male Rats. J Pharm Drug Deliv Res. 2012;1:2.
51. Pradeep KV, et al. Importance of ADME and Bioanalysis in the Drug Discovery. J Bioequiv Availab. 2013;5:e31.
52. Baumeister AA, et al. On the Exploitation of Serendipity in Drug Discovery. Clin Exp Pharmacol. 2013;3:e121.
53. Cheng SB. The Nervous System: An Ideal Therapeutic Target for Anti-Schistosomal Drug Discovery. Tropical Medicine & Surgery. 2013;1:e103.
54. Ravindran S, et al. Significance of Biotransformation in Drug Discovery and Development. J Biotechnol Biomaterial. 2012;S13:005.
55. Bhakta S. An Integration of Interdisciplinary Translational Research in Anti-TB Drug Discovery: Out of the University Research Laboratories to Combat Mycobacterium tuberculosis. Mol Biol. 2013;2:e108.
56. Pomin VH. Current Status of Fucanomics and Galactanomics in Drug Discovery and Glycomics. J Glycobiol. 2013;2:104.
57. Cheng F and Vijaykumar S. Applications of Artificial Neural Network Modeling in Drug Discovery. Clin Exp Pharmacol. 2012;2:e113.
58. Deshmukh R. Modeling and Simulation in Drug Discovery and Development. J Bioequiv Availab. 2012;4: 27-28.
59. Persaud-Sharma V and Zhou SF. Drug Repositioning: A Faster Path to Drug Discovery. Adv Pharmacoepidem Drug Safety. 2012;1:e117.
60. Sánchez HEP. Exploitation of Massively Parallel Architectures for Drug Discovery. Drug Des. 2012;2:e108.
61. Young W, et al. Patientspecific Induced Pluripotent Stem Cells as a Platform for Disease Modeling, Drug Discovery and Precision Personalized Medicine. J Stem Cell Res Ther. 2012;S10:010.
62. Yang Z and Marotta F. Pharmacometabolomics in Drug Discovery & Development: Applications and Challenges. Metabolomics. 2012;2:e122.
63. Patil SA. Role of Medicinal Chemist in the Modern Drug Discovery and Development. Organic Chem Curr Res. 2012;1:e110.
64. Medina-Franco JL. Drug Discovery with Novel Chemical Libraries. Drug Des. 2012;1:e105.

65. Liu Y. Renaissance of Marine Natural Product Drug Discovery and Development. J Marine Sci Res Development. 2012;2:e106.
66. Gonzalez-Sabin J. Natural Products: Back to the Future in Drug Discovery. Biochem Pharmacol (Los Angel) 2012;1:e112.
67. Pascu ML. The Laser Use in Generating New Species of Medicines with Antitumor and Antibacterial Properties: New Processes in Drug Discovery. Biochem Pharmacol (Los Angel). 2012;1:e111.
68. Elzahabi HAS. Virtual Screening in Drug Discovery, A Topic between Believe and Reality? Biochem Pharmacol (Los Angel). 2012;1:e103.
69. Nishant T, et al. Role of Pharmacokinetic Studies in Drug Discovery. J Bioequiv Availab. 2011;3:263-267.
70. Celikyurt IK. Thought-provoking Molecules for Drug Discovery: antioxidants. Pharm Anal Acta. 2011;S3:001.
71. Fortuna A, et al. In vitro and In vivo Relevance of the P-glycoprotein Probe Substrates in Drug Discovery and Development: Focus on Rhodamine 123, Digoxin and Talinolol. J Bioequiv Availab. 2011;S2.
72. Torzewski J, et al. Road Map to Drug Discovery and Development–Inhibiting C-reactive protein for the Treatment of Cardiovascular Disease. J Bioequiv Availab. 2011; S1:001.
73. Arun B. Challenges in Drug discovery: Can We Improve Drug Development. J Bioanal Biomed. 2009;1:050-053.
74. Subudhi BB, et al. Updates in Drug Development Strategies against Peptic ulcer. J Gastrointest Dig Syst. 2016;6:398.
75. Zhao Y. Towards Structural Based Drug Development for Ebola Virus Disease. J Chem Biol Ther. 2016;1:e101.
76. Ashok Kumar Panda. Ayurveda Treatment Outcomes for Osteoarthritis. J Homeop Ayurv Med. 2015;4:e115.
77. Jayram H, et al. Ayurvedic Regimen in Hemorrhagic Ovarian Cyst without Peritoneal Bleeding: A Case Report. J Homeop Ayurv Med. 2014;3:164.
78. Nazmul Huda Md, et al. Clinical Evaluation of an Ayurvedic Preparation for the Treatment of Iron Deficiency Anemia in Patients. J Homeop Ayurv Med. 2014;3:162.
79. Banamali D. Concept of Dietetics and its Importance in Ayurveda. J Homeop Ayurv Med. 2014;3:149.
80. Soluade KO and Do DP. Biosimilars: The New Era of Drug Development? J Bioequiv Availab. 2013;5:e40.
81. Panda AK. Comprehensive Ayurvedic Care in Type-2 Diabetes. J Homeop Ayurv Med. 2014;3:e111.
82. Panda AK. Complementary and Alternative Medicine is Mother Medicine. Altern Integr Med. 2013;3:e112.
83. Hazra J and Panda AK. Concept of Beauty and Ayurveda Medicine. J Clin Exp Dermatol Res. 2013;4:178.
84. Shintani H. Drug Development and Validation. Pharmaceut Anal Acta. 2013;4:e149.
85. Huang L. Inhibiting Protease Auto-processing: A Novel Strategy for Anti-HIV-1 Drug Development. Biochem Physiol. 2013;2:e115.
86. Aliev G, et al. Mitochondria Specific Antioxidants and their Derivatives in the Context of the Drug Development for Neurodegeneration and Cancer. Drug Des. 2013;2:103.
87. Sun L. Peptide-Based Drug Development. Mod Chem appl. 2013;1:e103.
88. Amin A and Lowe L. Plant-Based Anticancer Drug Development: Advancements and Hurdles. J Gastroint Dig Syst. 2012;2:e111.
89. Elsheikha H and Rauch CRedefining the Limits of Biochemistry in Multidrug Resistant Nematodes: Implications for Future Drug Development. J Vet Sci Technol. 2012;3:e110.

90. Bhattacharyya S. Application of Positron Emission Tomography in Drug Development. Biochem Pharmacol. 2013;1:e128.
91. Akkol EK. New Strategies for Anti-Inflammatory Drug Development. J Pharmacogenomics Pharmacoproteomics. 2012;3:e118.
92. Luisa BM, et al. Challenges Faced in the Integration of Pharmacogenetics/Genomics into Drug Development. J Pharmacogenomics Pharmacoproteomics. 2012;3:108.
93. Panda AK. Evidence based Ayurveda Practice. J Homeop Ayurv Med. 2012;1:e108Luisa BM, et al. Challenges Faced in the Integration of Pharmacogenetics/Genomics into Drug Development. J Pharmacogenomics Pharmacoproteomics. 2012;3:108.
94. Panda AK. Evidence based Ayurveda Practice. J Homeop Ayurv Med. 2012;1:e108.
95. Ansari R. Defining the Role of Single Nucleotide Polymorphic (SNP) in Drug Development and Toxicity. J Drug Metab Toxicol. 2012;3:e103.
96. Kummalue T. Difficulties of Drug Development from Thai Herbal Medicine. Pharm Anal Acta. 2012;S15:002.
97. Khan A and Khan AU. Biomarker Discovery and Drug Development: A Proteomics Approach. J Proteomics Bioinform. 2012;5: 5-6.
98. Sang N. Biochemistry, Drug Development and Open Access. Biochem Pharmacol. 201;1:e101.
99. Nicolson TJ, et al. The Post-Transcriptional Regulator EIF2S3 and Gender Differences in the Dog: Implications for Drug Development, Drug Efficacy and Safety Profiles. J Drug Metab Toxicol. 2010;1:101.
100. Avramidis D, et al. Regrowth Concentration Zero (RC0) as Complementary Endpoint Parameter to Evaluate Compound Candidates During Preclinical Drug Development for Cancer Treatment. J Cancer Sci Ther. 2009;1: 019-024.