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ALL DRUGS ARE CHEMICALS BUT ALL CHEMICALS ARE NOT DRUGS

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***ABSTRACT*:** *Pharmaceutical science deals with the drug and this drug is marketed in global range in the form of medicines for healthcare. Only the drug can bind with specific receptor to show desired biological action in-vivo whereas other chemical fails to show the same. All drugs are xenobiotics because it is coming from outer source (xeno) which is active in biological (biotics) system having less toxicity done by phase-I to phase-IV trials to pass the clinical aspects. Designing of lead molecule to most potent molecule and finally after crossing so many clinical trials this drug comes to the market in the form of some formulations incorporated with excipients. Paracetamol is para hydroxy acetanilide which is used as antipyretic because it binds at the receptor of heat regulating centre of cerebellum of brain but removing para hydroxy group it will become acetanilide which fails to bind at the same receptor to possess the biological activity. A specific drug can bind at specific receptor among huge receptors present in the body because its chemical structure fits at that specific receptor only and not for all receptors. No doubt that drug is definitely a chemical entity but all chemical entity never comes to the category of drug.*

KEYWORDS: xenobiotics, drug, API, excipients, medicine, receptor, druggist, FDA, enantiomers, clinical trials, therapeutic index, ion channels, lead molecule, potent molecule, biological action, toxicity

INTRODUCTION

Drug is a substance recognized by an official pharmacopoeia or formulary, intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease; a substance (other than food) intended to affect the structure or any function of the body; a substance intended for use

as a component of a medicine but not a device or a component, part or accessory of a device; biological products are included within this definition and are generally covered by the same laws and regulations, but differences exist regarding their manufacturing processes (chemical process versus biological process.)[1]

Figure-1: Drugs[1]

Drugs are the chemical substances which have definite structural framework obtained from either synthetic source or natural source (plant source, animal source, mineral source) which can bind with receptor bed having controlling capacity to check the biochemical malfunction with less toxicity. Medicines are the formulated drug in the form of pharmaceutical dosage form (tablet, capsule, injection, cream, ointment, inhalation etc) from drug so that it can be easily accumulated in the body.[2] Drugs are also known as active pharmaceutical ingredient (API) which can easily fit on bioreceptor platform. The human body maintains an intricate balance of thousands of chemical reactions. These systems must respond to constantly changing demands from the individual's activities. These systems are subject to challenges from defects and malfunctions resulting from genetic abnormalities, environmental challenges, changes accumulated through age and attacks from microorganisms.[3]

Pharmaceutical or a drug is classified on the basis of their origin.

Drug from natural origin: Herbal or plant or mineral origin, some drug substances are of marine origin.

Drug from chemical as well as natural origin: Derived from partial herbal and partial chemical synthesis Chemical, example steroidal drugs

Drug derived from chemical synthesis.

Drug derived from animal origin: For example, hormones, and enzymes.

Drug derived from microbial origin: Antibiotics

Drug derived by biotechnology genetic-engineering, hybridoma technique for example

Drug derived from radioactive substances.

One of the key classifications is between traditional small molecule drugs, usually derived from chemical synthesis, and biologic medical products, which include recombinant proteins, vaccines, blood products used therapeutically (such as IVIG), gene therapy, and cell therapy (for instance, stem cell therapies).

Figure-2: Medicines[2]

Pharmaceutical or drug or medicines are classified in various other groups besides their origin on the basis of pharmacological properties like mode of action and their pharmacological action or activity, such as by chemical properties, mode or route of administration, biological system affected, or therapeutic effects. An elaborate and widely used classification system is the Anatomical Therapeutic Chemical Classification System (ATC system). The World Health Organization keeps a list of essential medicines.[4]

A sampling of classes of medicine includes
Antipyretics: reducing fever (pyrexia/pyresis)
Analgesics: reducing pain (painkillers)
Antimalarial drugs: treating malaria
Antibiotics: inhibiting germ growth
Antiseptics: prevention of germ growth near burns, cuts and wounds
Mood stabilizers: lithium and valpromide
Hormone replacements: Premarin
Oral contraceptives: Enovid, "biphasic" pill, and "triphasic" pill
Stimulants: methylphenidate, amphetamine
Tranquilizers: meprobamate, chlorpromazine, reserpine, chlordiazepoxide, diazepam, and alprazolam
Statins: lovastatin, pravastatin, and simvastatin

Pharmaceuticals may also be described as "specialty", independent of other classifications, which is an ill defined class of drugs that might be difficult to administer, require special handling during administration, require patient monitoring during and immediately after administration, have particular regulatory requirements restricting their use, and are generally expensive relative to other drugs.[5]

In pharmacy, a formulation is a mixture or a structure such as a capsule, a pill, tablet, or an emulsion, prepared according to a specific procedure (called a “formula”). Formulations are a very important aspect of creating medicines, since they are essential to ensuring that the active part of the drug is delivered to the correct part of the body, in the right concentration, and at the right rate (not too fast and not too slowly). A good example is a drug delivery system that exploits supersaturation. They also need to have an acceptable taste (in the case of pills, tablets or syrups), last long enough in storage still to be safe and effective when used, and be sufficiently stable both physically and chemically to be transported from where they are manufactured to the eventual consumer. Competently designed formulations for particular applications are safer, more effective, and more economical than any of their components used singly.

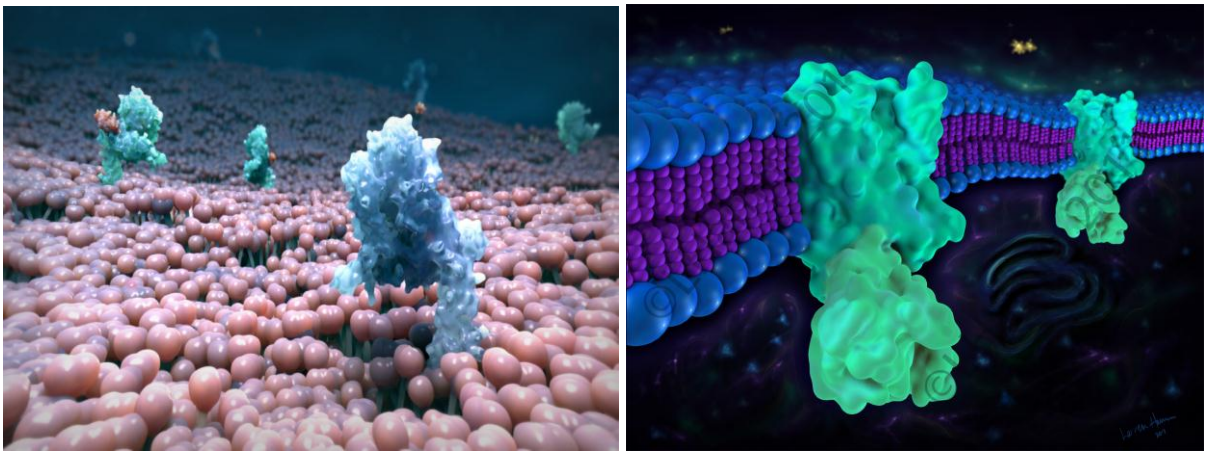

Figure-3: Receptor[6]

Pharmacy is a subject which runs on its two legs: chemistry and biology. Chemistry part involves in pharmaceutical chemistry including medicinal chemistry and quality assurance division which focus on synthesis and quality improvement by quality assurance followed by drug design. Chemistry is totally involved in pharmaceutics and biopharmaceutics through formulation strategy by dosage form design followed by physical chemistry aspects. Chemistry and biology both are also incorporated in pharmacology and bioanalytical division

where the drug-receptor concept is followed by quantitative structure activity relationship (QSAR) studies to produce the lead molecule to process for further toxicological assays followed by acute, sub-acute, chronic, teratogenic, carcinogenic studies to get lower therapeutic index by ED50/LD50. Clinical pharmacy gives the reports on clinical trials by phase-I, phase-II, phase-III and phase-IV studies on the drug. Pharmacognosy shows the origin of drug from natural source (plant, animal and mineral) sources to get the parent moiety for various substitutions to produce a potent drug. Drug or active pharmaceutical ingredient (API) which is a xenobiotic because it is administered into the body from outer source which is a chemical entity having specific structural network having property to bind with macromolecular bioreceptor platform to control the biochemical malfunction inside the body with minimum toxicity. A drug can't be administered directly into the body, so it is formulated into a specific formulation (tablet, capsule, injection, inhalation, cream/ointment etc.) so that it can be easily taken by patient with no compliances.[6]

Figure-4: Druggist[7]

A pharmaceutical drug (also referred to as a medicinal product, medicine, medication, or medicament) is a drug used to diagnose, cure, treat, or prevent disease. Drug therapy (pharmacotherapy) is an important part of the medical field and relies on the science of pharmacology for continual advancement and on pharmacy for appropriate management. Drugs are classified in various ways. One of the key divisions is by level of control, which distinguishes prescription drugs (those that a pharmacist dispenses only on the order of a physician, physician assistant, or qualified nurse) from over-the-counter drugs (those that consumers can order for themselves). Another key distinction is between traditional small molecule drugs, usually derived from chemical synthesis, and biopharmaceuticals, which

include recombinant proteins, vaccines, blood products used therapeutically (such as IVIG), gene therapy, and cell therapy (for instance, stem cell therapies). Other ways to classify medicines are by mode of action, route of administration, biological system affected, or therapeutic effects. An elaborate and widely used classification system is the Anatomical Therapeutic Chemical Classification System (ATC system). The World Health Organization keeps a list of essential medicines. Drug discovery and drug development are complex and expensive endeavors undertaken by pharmaceutical companies, academic scientists, and governments. Governments generally regulate what drugs can be marketed, how drugs are marketed, and in some jurisdictions, drug pricing. Controversies have arisen over drug pricing and disposal of used drugs.[7]

Classification

1. Drugs acting on respiratory tract: Antiasthmatics, Expectorants, Antitussive agents, Mucolytics, Decongestants

2. Drugs acting on gastrointestinal tract: Antacids, Antisecretary (Ranitidine), Proton pump inhibitors (Omeprazole), Antiemetics, Antidiarrheals, Laxatives, Antispasmodics

3. Drugs acting on histamines: Antihistaminics: H1antagonists

4. Drugs Acting on CNS:

i. CNS stimulants: Analeptics, Antidepressants, Hallucinogens

ii. CNS depressants: General and local anesthetics, Sedative and Hypnotics, Anxiolytics, Antiepileptics, Antipsychotics

5) Drugs acting on ANS: Salbutamol, Propranolol, Neostigmine, Dicyclomine

6) Drugs acting on Parkinson disease: Dopamine. levodopa

7) Non Steroidal Anti-Inflammatory Agents, Anti Gout

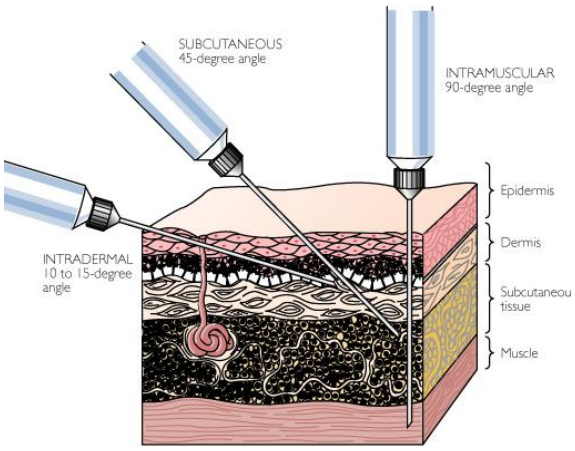

Figure-5: Parenteral drugs[3,5]

8) Drugs acting on microbes:

i. Synthetic Antibacterial Agents/Antimicrobial Agents: Sulfonamides, Quinolones, Sulfacetamide, Sulfadoxin, Sulfamethoxazole, Sulfasalazine, Trimethoprim, Norfloxacin, Ofloxacin, Ciprofloxacin.

ii. β-Lactam Antibiotics: Cephalosporins, Penicillins

iii. Tetracyclines, Aminoglycosides, Macrolides Antibiotics: Aminoglycosides, Tetracyclines, Macrolides, Chloramphenicol

iv. Antimycobacterial Agents: Ethambutol, Isoniazid, Pyrazinamide, Clofazimine, PAS.

v. Antifungal Agents: Clotrimazole, Ketoconazole, Fluconazole

vi. Antiprotozoal Agents: Antimalarial and Antiamoebic Agents

vii. Metronidazole, Ornidazole, Chloroquine, Amodiaquine, Primaquine, Pyrimethamine.

viii. Anthelmintics: Albendazole, Mebendazole.

ix. Antiviral and Anti-HIV Agents: Amantadine

9) Drugs acting on diabetes: Glipizide, Metformin, Pioglitazone, Tolbutamide, Glimipride.

10) Drugs acting on Thyroid Hormones and Antithyroid Drugs: Thyroxine, Methimazole, Carbimazole.

11) Steroids and Therapeutically related compounds: Estrogens, Progestins and Androgens

12) Drugs acting on heart:

i. Cardiotonic Agents: Cardiac glycosides

ii. Antihypertensive Agents: Nifedipine, Amlodipine, Atenolol, Metoprolol, Carvediol, Captopril, Hydralazine.

iii. Antiarrhythmic Agents: Lignocaine, Flecainide.

iv. Antianginal Agents: Glyceryl trinitrate, Isosorbide dinitrate

v. Antihyperlipidemic agents: Clofibrate

13) Coagulants and Anticoagulants: warfarin

14) Diuretics: Hydrochlorthiazide, Acetazolamide, Furosemide, Dihydroflumethiazide, Ethacrinic acid

Thalidomide has two optical isomers, one of which is a powerful teratogen.

Developed in Germany in the 1953. Used as a tranquilizer (1957-1962). Prescribed to combat morning sickness in the early months of pregnancy. Marketed widely in Europe but never approved by the FDA in the USA. Caused major birth defects in ABOUT 10,000 children whose mothers had taken thalidomide.[8]

Drug Development: All medicines have some side effects and the appropriate dosage must be determined.

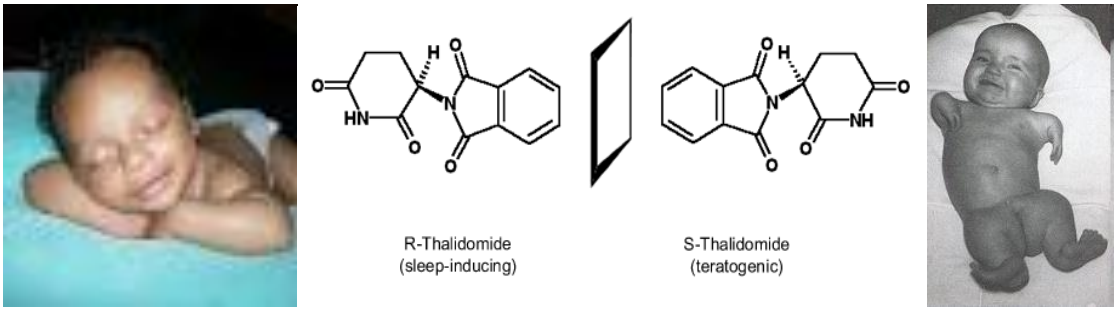

Figure-6: Dual effect of enantiomers[8]

To determine the following must be considered

Lethal Dose or LD50, Effective Dose or ED50, Therapeutic Index, Toxic Range, Therapeutic Level, Sub-therapeutic level. Research, Development and Drug Testing: The development of a new drug is a time consuming process by determination of the Lethal Dose or LD50. This is the concentration that will kill 50% of the animals in a test sample

The Effective Dose or ED50. is the concentration necessary to bring about a noticeable effect in 50% of the test sample

Figure-7: FDA approved drugs for human[9]

The Therapeutic Index is the ratio of LD50/ED50.

Research, Development and Drug Testing: Development of new drugs is long and expensive process.

Several stages in development include: Isolation or chemical synthesis, Laboratory studies, Animal testing to determine LD50, Clinical testing to determine effectiveness, Approval by the FDA for market.[9]

Methods of Administering Drugs

Drugs must reach blood stream to be transported to critical tissues.

The method of administration determines rate at which the drug is absorbed in the blood.

Five common points of entry: Oral, Inhalation, Topical, Injection, Anal

Injection methods

Intradermal: Between layers of skin

Subcutaneous: Under the skin

Intramuscular: In the muscle

Intravenous: Directly in the vein

Lines of Defense

Barriers to prevent entry, Skin, Mucous membranes, Closures and secretions of natural openings: lips, eyelids etc, Defense against attack invaders, White blood cells (Phagocytes), Blood clotting to prevent blood loss, Inflammatory response.

Immune system: Antibodies, Memory cells to enable the body to fight repeat invasions.

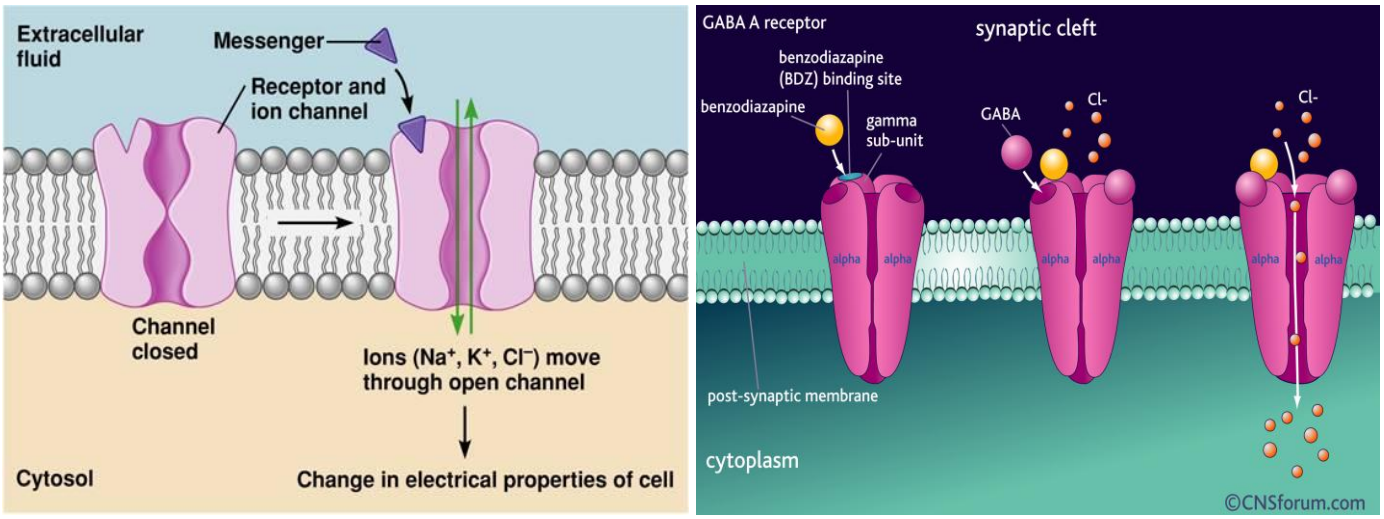

Figure-8: Ion channels for drug action[10]

Origins of Pharmacology

From earliest times people have used natural substances such as medicinal herbs to: relieve pain, heal injuries, cure diseases. Some folk remedies contained certain active ingredients that were of medicinal value. Access to drugs and medicines is controlled in most countries but the definition of what constitutes a drug may vary.[11]

Examples: Melatonin, Codeine

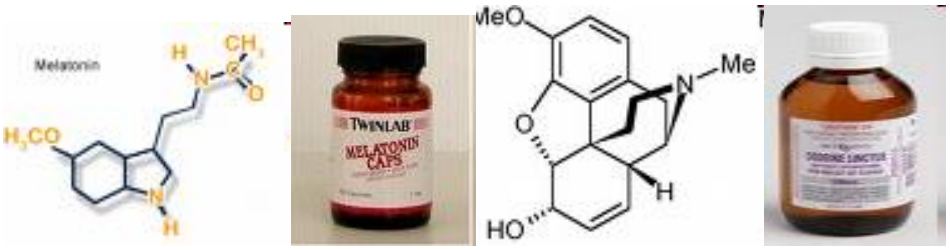

Figure-9: Drugs & Medicines[16,17]

Clinical Trials: All drugs that are approved for market must be clinically tested multiple times. Most clinical tests are done on volunteers using a double blind study. Some of the volunteers receive a placebo while others receive the therapeutic medicine. Neither the researcher nor the participants know in advance who receives which placebo treatment.

Contraindications or Side Effects: Contraindications are additional and often undesirable effects that result from the use of a particular drug to treat a particular condition. Side effects are somewhat relative depending on the reason the drug is prescribed.

Tolerance: Over time the body adapts the presence of a drug. The person receiving the drug needs ever larger doses to achieve the original effect. Tolerance results in increased risks of dependency/addiction. Increased risks of toxic levels. Possibility of immunity in anti-bacterials.[12]

Overview

Disease is such an unwanted manifestation that is undesired to all but when it attacks to any body then medication is the first priority to get well soon and that is managed by drug. Drug itself is very unpleasant in taste when it is to be suggested to take orally, so it is then formulated in the form of solid dosage form (tablet, capsule); when liquid dosage form (syrup); when injectables (intramuscular, intravenous, subcutaneous); when external (cream, ointment); when spray (aerosol). Any API or drug is incorporated with various excipients to formulate specific medicine so that it can be easily administered without any difficulty. Drug as a chemical moiety has some toxicity and this can be minimised by drug development to minimise the therapeutic index. Drugs are mostly organic entity and excipients are mostly inorganic substances but the structural network of both drugs and excipients of medicines are composed by single element which is placed in periodic table (C, H, N, O, S, P, F/Cl/Br/I etc. for organics & Na, K, Mg, Al, Zn, Fe etc. for inorganics). All these elements make a bond

between each other by catenation property to give structural network of organic as well as inoganic matters. Organic substances which only bind on receptor bed in the form of medicine has capability to fight with disease which is biochemical malfunction of normal health.[13-17]

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The author Prof Dr Dhrubo Jyoti Sen did undergraduate to doctorate degrees in pharmaceutical sciences from Jadavpur University, Calcutta during 1988-2000 and during his study he learnt about basics of drugs and medicines form two esteemed learned professors of medicinal chemistry. The due mastero of medicinal chemistry (Prof Dr Arun Uday De and Prof Dr Samir Chandra Lahiri) used to say a very nice truth "All drugs are chemicals but all chemicals are not drugs" in BPharm and MPharm classes. Prof Sen accumulated this coin at that time in past millennium and applied the same in current millenium in the form of article in details about that. This exclusive article pays homage to both of the learned personalities who are now heavenly abode.

REFERENCES

1. https://en.wikipedia.org/wiki/Drug
2. https://en.wikipedia.org/wiki/Medicine
3. https://en.wikipedia.org/wiki/Active_ingredient
4. https://en.wikipedia.org/wiki/Xenobiotic
5. Dhaval K. Patel and Dr. Dhrubo Jyoti Sen; Xenobiotics: an outsource entity but active in living system: American Journal of Advanced Drug Delivery, 2013; 1(3): 262-270.
6. Sandip N. Badeliya and Prof Dr Dhrubo Jyoti Sen; Bioreceptor platform: a macromolecular bed for drug design: Asian Journal of Research in Chemistry, 2010; 3(4): 815-823.
7. http://www.thefreedictionary.com/druggists
8. http://www.chm.bris.ac.uk/motm/thalidomide/optical2iso.html
9. https://en.wikipedia.org/wiki/Food_and_Drug_Administration
10. DC Camerino, D Tricarico, JF Desaphy; Ion channel pharmacology. *Neurotherapeutics,* 2007; 4(2): 184–198.
11. A. Jagan Mohan Reddy, Manas Ranjan Barik, Gajendra L. Muli and T. Parthasarathy; Computational Approach for Designing and Development of Potent Inhibitor for

Hepatitis - B Virus X- Associated Protein through Molecular Docking Studies; Journal of Chemical and Pharmaceutical Research, 2012; 4(1): 265–271.

12. https://en.wikipedia.org/wiki/Therapeutic_index
13. https://en.wikipedia.org/wiki/Lead_compound
14. https://en.wikipedia.org/wiki/Biological_activity
15. https://en.wikipedia.org/wiki/Toxicity
16. Vikramkumar Vishnubhai Patel, Prof. (Dr.) Dhrubo Jyoti Sen and Prof. (Dr.) Satyanand Tyagi; Correlation between cheminformatics and bioinformatics in drug discovery: a farsight of pharmacy-the millennium oath: Journal of Drug Discovery and Therapeutics, , 2013; 1(5): 47-54.
17. Prof. Dr. Dhrubo Jyoti Sen; DrugBank as a recognized bank of drugs having ATM card in database: World Journal of Pharmaceutical Sciences, 2015; 3(1): 1-9.