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Rx FACTOR

News letter by

NATIONAL ASSOCIATION OF PHARMACOLOGY AND THERAPEUTICS

www.nationalpharmacology.org

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Supported by

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From editorial desk

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Warm greetings to all.

Welcome to the Volume 5 of '**RxFactor**', a one of a kind initiative from the NATIONAL ASSOCIATION OF PHARMACOLOGY AND THERAPEUTICS (NPT) . RxFactor has been designed to encompass the range and breadth of Pharmacology and therapeutics ranging from Medical Education, Pharmaco-vigilance, Research and Therapeutics. Previous editions of Rxfactor have been well received and we thank you all for the words of encouragement and appreciation.
This edition of Rxfactor newsletter has many useful articles like a new emerging approach for medical diagnostics and therapy, called 'Nanogenomics', use of online approach to conduct an integrated teaching session of medical students, an interesting case report on FDE caused by Fluroquinolones-Nitroimidazole and Novel biologics for asthma. We also have articles that are critically looking at the newer drugs like Tirzepatide and Omidenepag isopropyl that have been approved by FDA recently.

The COVID pandemic has brought to the fore crucial challenges to clinical research including scarcity of trial participants, restricted access to research settings and lack of trial supplies etc. Virtual Clinical Trials appear to be an effective solution to this challenge and the current issue throws light on these trials. The Amazing Drug molecules section which enlists drugs with multiple mechanism of action and the Extract from NMDP group are some of the other notable inclusions. Further, as always the 'cool corner' has a crossword & cartoons to add a fun element to pharmacology learning.

The current issue also has details regarding one of the most important and hugely successful events of this year, the Annual Conference of National Association of Pharmacology and Therapeutics (NAPTICON) being organised by the Dept of Pharmacology , Father Muller Medical College, Mangalore on 28 th and 29th November with a pre-conference wksp on 27 th Nov 2022.

We would like to thank all the contributors of RxFactor for their efforts and support in making this issue of Rxfactor a grand success. We look forward to a happy education and mutual learning with all our readers.

Jai Hind.

Dr. Sushil Sharma

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For publication your contents
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NANOGENOMICS : A PURVIEW FOR PERSONALIZED MEDICINE

Image courtesy: AzoNano

Nanogenomics is a novel research domain that integrates nanobiotechnology and genomics. It unfolds a new arena of medical diagnostics and therapy by incorporating bioinformatics and biomolecular sciences. Despite the advent of nucleic acid in molecular biology, lacunae exist between the traditional medical approach and the molecular world. Nanogenomics is inspired by the data generated by the "omics" – driven techniques and high-throughput technologies. Being a promising strategy for the analysis of gene expression, DNA microarrays facilitate the evaluation of several genes (>10,000) in a single experiment, thereby enabling the visualization of a whole genome. Commercial arrays with a limited number of genes (usually 150-200) are currently available but often scrutinized without focussing on a specific target for testing.

EVOLUTION OF NANOGENOMICS

Richard Feynman, an American physicist and Nobel Prize laureate introduced the "nanotechnology" concept in 1959 and is proudly referred to as the "Father of modern nanotechnology". Norio Taniguchi, a Japanese scientist in 1974 defined the term "nanotechnology". Kim Eric Drexler presented his publication "The Coming Era of Nanotechnology," in 1981 which gained therapeutic insights for healthcare concerns. Nadrian Seeman was the first to lay out the conceptual foundation for DNA nanotechnology in 1982. The Nobel Prize in Physics was awarded to Binnig and Rohrer in 1986 for their design of "Scanning Tunneling Microscope and Scanning Probe Microscopes". In 2006, Paul Rosemond developed the "scaffolded DNA origami", by enhancing the complexity and size of self-assembled DNA nanostructures in a "one-pot" reaction.

APPROACHES IN NANOGENOMICS

Biological samples such as saliva, blood, urine, and biopsies were retrieved from patients and subjected to analysis for differentially expressed genes (DEGs) via both statistical and not- statistical analyses with the Leader Genes algorithm and in-house microarray scanner termed DNASER (DNA analyzer), molecular tools meant for the selection of few important highly interconnected genes. This ab initio-targeted microarray-based bioinformatics and nanogenomics led to a panel of a few identified genes that can be expressed in a cell-free environment with Nucleic Acid Programmable Protein Array (NAPPA) technologies. This also utilizes a complex mammalian cell-free expression system for protein synthesis.

APPLICATIONS OF NANOGENOMICS

Retinopathy

Nanotechnology incorporated unique approaches to treat retinopathies. Many laboratories are involving viruses to deliver genes targeted to treat diseases. Viruses, however, can themselves cause problems by inducing inflammation in addition to over or under-expression of genes. Thus, the goal is modulated to focus on delivering the therapeutic genes without a virus, using nanoparticles. The nanoparticles can be made of multiple layers in such a way that the outer layer possesses peptides channelling the particles to cells of interest. Once the particles get into the target cell, the genes are expressed for a limited period. Using the genes for naturally occurring antiangiogenic factors, the nanoparticles can also carry a biosensor DNA that will allow the gene to be expressed only when it is needed.

Chronic kidney disease

The "OMICS" data generated by high-throughput technologies, converged together into the transpantomics approach by enabling the discovery of predictive and personalized biomarkers. Using the Leader Gene algorithm, which takes into account gene expression, gene connectivity and biological pathways, the identified eight genes were termed "hub genes". It was found that five out of eight genes can distinguish between rejection and tolerance to kidney transplantation, being differentially expressed between the two groups of patients in a statistically significant way. Some of these genes have been rarely described as predictors of clinical outcomes to renal graft in the extant literature.

NANOGENOMICS : A PURVIEW FOR PERSONALIZED MEDICINE....Contd

Nanoparticles used in Gene Therapy

Polymer nanoparticles:

Polymer nanoparticles (PNPs) deliver genes or therapeutic proteins including drugs in dissolved or encapsulated form as a nanoparticle and a nanocapsule respectivel

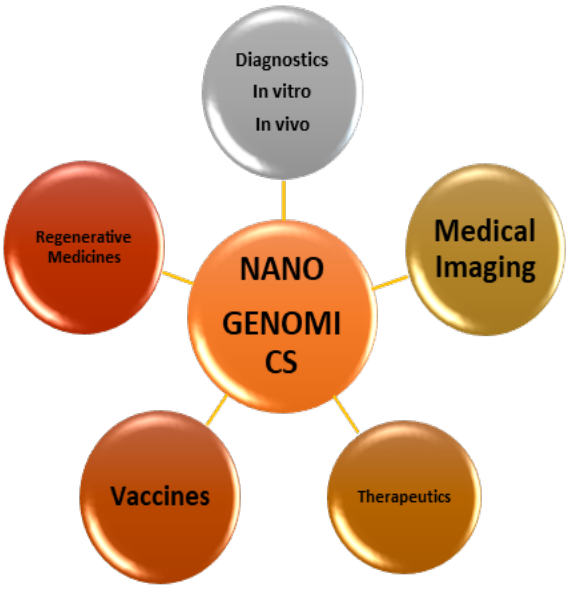
Magnetic nanoparticles

Paramagnetic nanoparticles act as drug carriers and get accumulated in target tissues using strong magnetic fields, especially in malignancy treatment.

Gold nanoparticles

Gold nanoparticles (Au NPs), are non-toxic tailor-made gene delivery vehicles and their optical and physio-chemical properties allow for easy transfection into cells.

VARIOUS OTHER APPLICATIONS



Conclusion

Nanotechnology and genomics explore the horizon of innovative therapeutics with a preponderance of solution-driven strategies. Nano-based drug therapies possess alleviated drug toxicity and better access to the target site, still, the therapeutic concentration must also be considered. Bioinformatics transmits an added value to nanogenomics along with the development of technology in computing leader genes automatically at a desired biological unit. Thus, the field of nanogenomics is blooming to address the potential challenges in the medical field.

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First Annual National Conference of National Association of Pharmacology and Therapeutics

Theme: Pharmacology Expertise For Changing Times

The First Annual National Conference of National Association of Pharmacology and Therapeutics Organized by Department of Pharmacology Father Muller Medical College at Mangalore on 28th& 29th October 2022 with a pre-conference workshop on 27 th October 2022. A total of 450 delegates and co-delegates had registered for NAPTICON 2022. The pre-conference workshop empowered the participants on "How to plan, prepare, implement and evaluate a simulated educational session in pharmacology". The main conference began with a glittering inaugural ceremony. The two day conference was a feast of academics with plenary sessions by eminent experts, Panel discussions, Quiz for post graduates and opportunity for young pharmacologists in the form of YPS sessions. There were a total of 80 oral papers and 80 e-posters which were presented by the delegates during the conference. NAPTICON 2022 was a great success and the participants went back truly enriched with a renewed commitment to raise the standard of pharmacology specialty in our country.

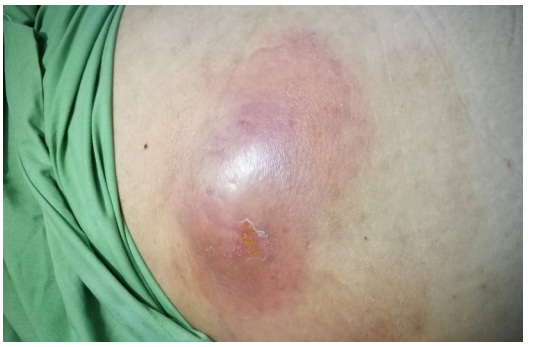
Pre conference workshop

Inauguration of conference

Glimpses from NAPTICON 2022

Title: Injection Abscess
Type of integrated teaching session: Horizontal
Departments involved: Surgery (Linker – case scenario), Pharmacology, Pathology and Microbiology
Coordinator Department: Pharmacology
Faculty involved:
Scheduling and drafting the module by CBME curricula II Phase Subcommittee faculties and CBME II Phase coordinator. Program conducted by the allotted faculties of Microbiology, Pathology Pharmacology and General surgery. IT session was coordinated by the department of Pharmacology.

Day one: SDL

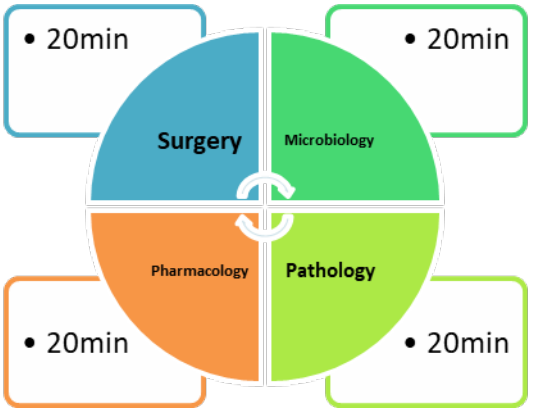


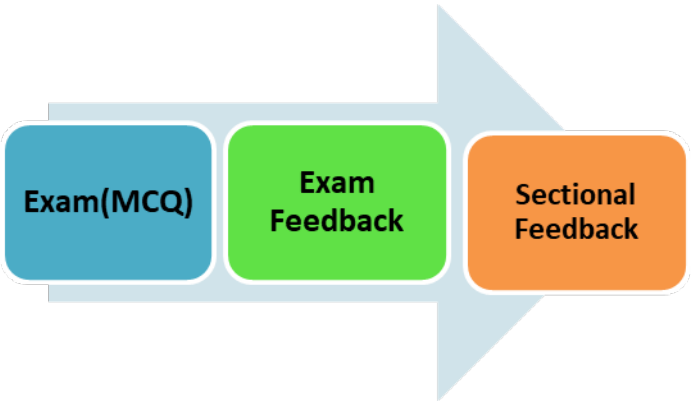
All the three departments provided relevant teaching material (**title/ previous class contents /references)** were given with assignment and questions through II Phase class students common what's app group and students were instructed to send the completed assignments (scanned copy of hand written format in white sheet with name , signature and register number within 8 hours to the concerned mail id provided by the concerned II Phase department.

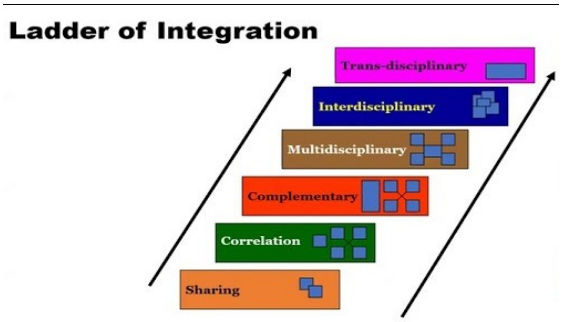
Day Two: Integrated Teaching session

Time	**3 hours**
Surgery faculty opened up injection abscess case scenario/ video and discussion:	**20 minutes**
Microbiology: Microbes responsible for Injection abscess	**20minutes**
Pathology: Inflammation and healing	**20 minutes**
Pharmacology faculty: Drug treatment	**20 minutes**
Exam (MCQ): Google forms	**60 minutes**
EXAM Feedback: Addressed to each dept by the students individually in dialogue box:	**10 minutes**
Summary: 10 minutes to II Phase department's to summarize and discuss MCQs	**30 minutes**

Sectional Feedback: All students individually were replied about IT though few questions through mail to the concerned departments**.**







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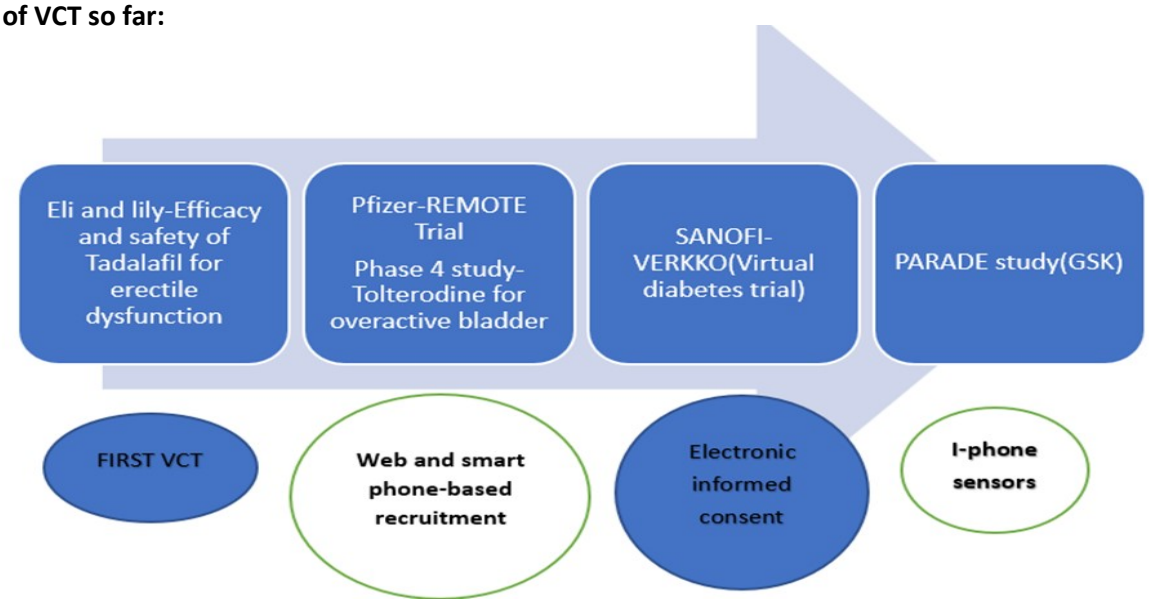
VIRTUAL CLINICAL TRIAL-A QUICK GLANCE

What are virtual clinical trials?

Virtual clinical trials (VCT) are novel method of conducting clinical research using technologies like apps and electronic monitoring devices. It enables participation remotely rather than at a physical clinical study site. Virtual clinical trials unquestionably make use of tele-health/digital technology to conduct secure and superior clinical trial research by including virtual patient monitoring, wearable medical devices, etc. These virtual studies are convenient, affordable, and patient-focused.

Journey of VCT so far:



Are we compromising a lot while working for a patient friendly trial setting?

PROS

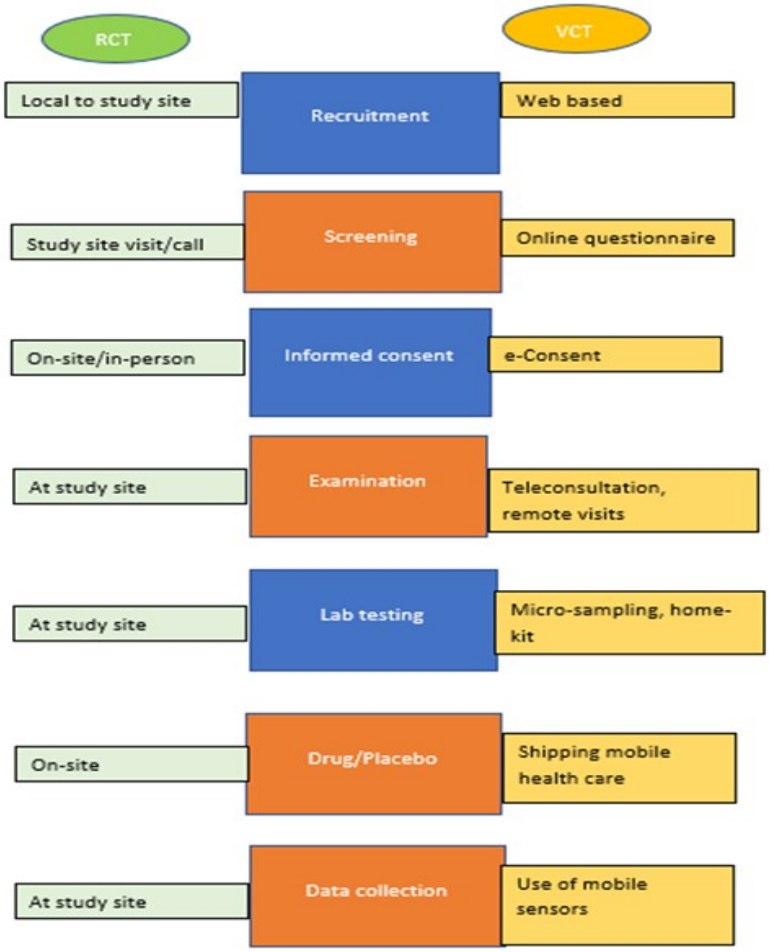
More diverse patient population
Patient friendly
Centralised data collection
Increased reporting
Less site required
Cost effective

CONS

Chance for convenience sampling
Difficulty in co-ordination of all the teams
Web based data submission-Quality?
Lack of guidelines

Rx Research Corner

How is it different from a conventional RCT?



The Journey ahead for VCT:

In order to provide even more engaging virtual patient interactions in clinical trials, improved versions of artificial intelligence, robotic process automation (RPA), and machine learning are probably going to be incorporated into the virtual trial solutions in the next years. The future is incredibly bright.

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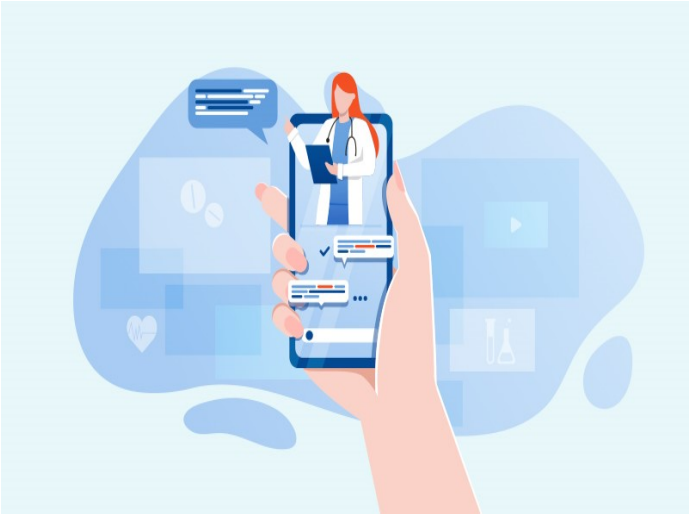


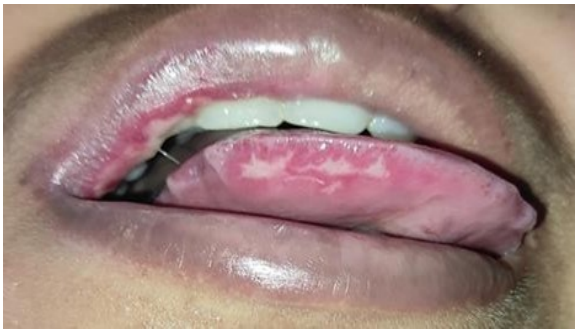
Fluroquinolones-Nitroimidazole fixed-dose combination induced Fixed Drug Eruption with positive rechallenge : A Case Report

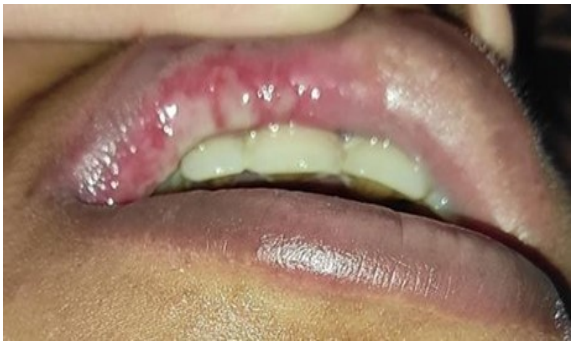
Background:

Fluroquinolones-Nitroimidazole fixed-dose combinations like Ofloxacin- Ornidazole, Norfloxacin-Tinidazole are commonly prescribed antimicrobial combination for Gastrointestinal disease[1]. But the Fixed drug eruption (FDE) [2]caused by these FDCs are under reported. FDEs are not only limited to single drug, but also cross sensitivity and poly-sensitivity among different members of the same pharmacological class do present[3,4].

Case Description:

A 32years young Female took Ofloxacin- Ornidazole FDC tablet after repeated episodes of loose motion. After taking Single tablet she developed generalized itching followed by 2-3 polymorphic, ulcerative, painful 0.5 -1cm in diameter lesions over the buccal mucosa at inner side of upper lip. She stopped the drug and consulted physician. Physician discontinued the drug and started her on Norfloxacin-Tinidazole FDC. After taking the new drug there was increase in number and severity of ulcerative lesions. So, patient consulted a dermatologist and drug was withdrawn and she was treated with antihistaminic (Cetrizine 10mg Tablet)and analgesic gel. There was no history of any concomitant medication.





Polymorphic,Ulcerative,Painful Lesions over Buccal Mucosa

Case Discussion:

This ADR is reported in VigiFlow Software (Worldwide unique ID IN-IPC- 300650406).

Here past treatment records confirmed accidental rechallenge. As eruptions occurred in the same site on re-exposure to the same drugs, it was diagnosed as fixed drug eruptions. FDE is a form of delayed-type

According to WHO-UMC Causality Assessment Scale the association between the drugs and the adverse drug reaction was found to be certain.

Assessment Criteria	Result
Temporal Relationship	Present
Biological Plausibility	Present
De-challenge	Positive
Rechallenge	Positive

Conclusion:

FDEs due to FDCs of different fluoroquinolones and nitroimidazoles are rare although they are individually notorious to cause FDEs[6]. The importance of eliciting drug allergy is highlighted here. It shows that physician should avoid prescribing the offending drugs or same pharmacological group of drugs again.

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NOVEL BIOLOGICS FOR ASTHMA: AN EPITOME

Asthma is a common hyperactive airway disorder affecting millions of people worldwide and attributes to nearly 4 lakhs deaths globally. This disease is strongly influenced by immune-mediated cascades such as IgE production, eosinophil proliferation and activation of mast cells due to the action of elevated T-helper cell cytokines like interleukin (IL)-4, IL-5, IL-13 etc. The therapeutic role of biologics in asthma was promoted owing to its anti-inflammatory and immunosuppressive effects, steroid-sparing activity and efficacy in the treatment of resistant variants of severe asthma. Omalizumab was the first approved biologic for moderate to severe asthma in patients aged more than or equal to 12 years with additional benefits such as a decline in the number and severity of asthma exacerbations. In continuation with omalizumab, many novel biologics such as mepolizumab, reslizumab, benralizumab and dupilumab were approved for the treatment of asthma in both children and adults. Newer biologicals modulating novel targets such as itepekimab and etokimab against IL-33, brodalumab targeting IL-25 and astegolimab blocking IL-33 receptor are in the development pipeline for asthma management.

NEWER FDA-APPROVED BIOLOGICS FOR ASTHMA

MEPOLIZUMAB
- Humanized IL-5 antagonist
- Approved for ages more than or equal to 6 years as an add-on drug for severe asthma
- Halt eosinophil activation and retard production and longevity of IgE
- Clinical trials: DREAM trial, MENSA study, SIRIUS trial
- Administered as subcutaneous injection of 100 mg once in 4 weeks
- ADR: Headache, injection site reaction, fatigue and back pain

RESLIZUMAB
- Anti IL-5 antibody
- Approved for patients aged more than or equal to 12 years diagnosed with severe eosinophilic asthma and not responding to other drugs
- Dose: 3 mg/Kg IV administered once in 4 weeks
- ADR: Blackbox warning denoting hypersensitivity reactions in 0.3% patinets

BENRALIZUMAB
- Acts against IL-5 receptor
- Affects IL-5 binding to eosinophil leading to its destruction via natural killer cells.
- Approved as an add-on therapy for severe asthma in patients more than or equal to 12 years
- CALIMA study, SIRICCO study
- Dose: 30 mg s.c. once in 4 weeks upto three doses followed by once in 8 weeks
- ADR: Headache & pharyngitis

DUPILUMAB
- Acts against IL-4 and IL-13 receptor
- Blocks binding of IL-4 to alpha subunit of its receptor
- Approved for patients with moderate to severe asthma and age more than or equal to 12 years as a part of maintenance therapy
- Also approved for chronic rhinosinusitis with nasal polyposis
- LIBERTY ASTHMA QUEST study, LIBERTY ASTHMA VENTURE trial
- ADR: Injection site pain, oropharyngeal pain and eosinophilia
- Dose: Initial dose of 400 mg s.c followed by 200 mg every 14 days.

TEZEPELUMAB
- Anti-thymic stromal lymphopoietin (TSLP) antibody
- Blocks TSLP that activates T helper 2 cells
- Approved for maintenance therapy of severe asthma as an add-on drug
- PATHWAY trial, NAVIGATOR trial, CASCADE trial
- Dose: 210 mg s.c once in 4 weeks
- ADR: Injection site reactions, joint pain, back pain

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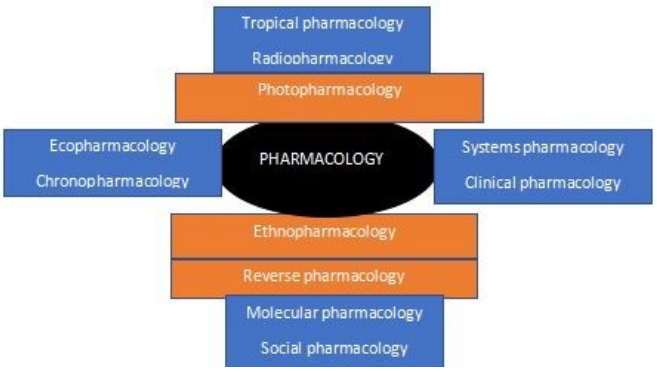
Let us all agree with the terms



Photopharmacology encompasses the introduction of photo-responsive/photoswitchable substructures into the pharmacophore of a known drug. Appropriate tuning of photo-chemically induced structural changes can influence the biological activity of the photoresponsive molecules and hence the pharmacodynamics and pharmacokinetic properties of the drug.

Ethnopharmacology relates to the study of substances used medicinally by different ethnic or cultural groups or handling of, drugs-based ethnicity or pharmacogenetics.

Reverse Pharmacology is a science of integrating documented experiential hits, into leads by transdisciplinary exploratory studies and further developing into drug candidates by experimental research. In this approach, the candidate travels a reverse path from 'clinics to laboratory' rather than classical 'laboratory to clinics.'

Ecopharmacology also referred as environmental pharmacology, pharmaco environmentology and ecopharmaco stewardship. Ecopharmacology is a new concept and an emerging science which deals with the Pharmaceuticals in environment [PIE] and the adverse impact of the pharmaceutical active ingredients on the environment.

Chrono pharmacology is the science dealing with the optimizations of drug effect and the minimizations of adverse effects by timing medications in relation to biological rhythm. The goal is to improve the understanding of periodic and thus predictable changes in both desired effects and tolerance of medication.

Systems Pharmacology is the quantitative analysis of the dynamic interactions between drugs and a biological system to understand the behaviour of the system as a whole, as opposed to the behaviour of its individual constituents; thus, it has become the interface between pharmacometrics and systems biology.

Clinical pharmacology is the study of drugs in humans. It is underpinned by the basic science of pharmacology, with added focus on the application of pharmacological principles and methods in real world whole populations. It has a broad scope, from the discovery of new target molecules, to the effects of drug usage in whole populations.

Tropical pharmacology is the study of the effects of drugs and other substances on the human body in warm, humid, and disease-prone endemic regions. Some examples of tropical pharmacology drugs used for treating malaria, dengue, yellow fever, Zika, and HIV/AIDS.

Radiopharmacology is the study and preparation of radiopharmaceuticals, which are radioactive pharmaceuticals. Radiopharmaceuticals are used in the field of nuclear medicine as tracers in the diagnosis and treatment of many diseases.

Social Pharmacology deals with evaluating the social consequences of using a drug in the individual and also studies the overall effect of the marketed drug in the society level. It deals with studying the relationship between different factors that include doctors prescribing, properties of the drug, inter-individual variations that will finally determine the therapeutic outcome of a marketed drug.

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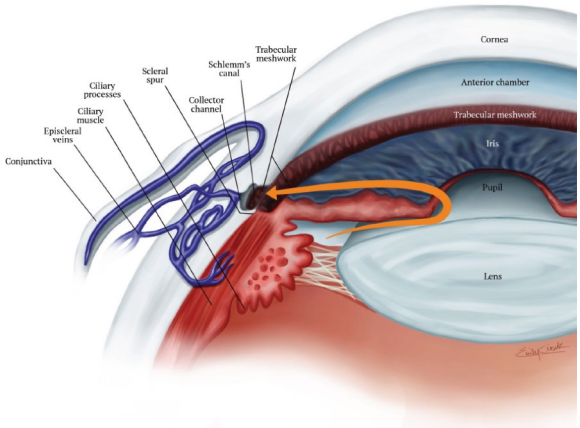
OMIDENEPAG ISOPROPYL

Selective Prostaglandin E2 receptor 2 agonists

Ube Industries and Santen Pharmaceutical developed omidenepag isopropyl ophthalmic solution 0.002%, a selective prostaglandin E2 receptor 2 agonists with a non-prostaglandin structure, for the treatment of glaucoma and ocular hypertension in Japan, Singapore, and the USA. Omidenepag isopropyl ophthalmic solution 0.002% was approved in Japan in September 2018 for this use based on the findings of phase III trials. FDA approved this drug on September 30, 2022 for glaucoma/ ocular hypertension. The development of Omidenepag isopropyl ophthalmic solution 0.002%, which resulted in this first global approval for the treatment of glaucoma and ocular hypertension, is summarised in this mini review.

Mechanism of action[1]

Omidenepag isopropyl is hypothesised to lower ocular pressure through a dual mode of action that involves enhancing trabecular outflow capacity as well as uveoscleral outflow due to EP2 receptor stimulation, which in turn promotes aqueous outflow.



Structure and Mechanisms of Trabecular Outflow

Pharmacokinetics[2]

During corneal penetration, the isopropyl ester derivative omidenepag isopropyl hydrolyses to produce the active metabolite (omidenepag). The omidenepag half-life was 0.5 hours. Omidenepag plasma concentrations were below the limit of quantification. 4 hours after receiving omidenepag isopropyl ophthalmic solution 0.002%, (1.00 pg/mL).

Adverse effects[3]

The most frequent adverse effect is conjunctival hyperaemia as well as macular edema including cystoid macular edema.

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3.Aihara M, Lu F, Kawata H, Iwata A, Liu K, Odani-Kawabata N, Shams NK. Phase 2, randomized, dose-finding studies of omidenepag isopropyl, a selective EP2 agonist, in patients with primary open-angle glaucoma or ocular hypertension. Journal of Glaucoma. 2019 May 1;28 (5):375-85.

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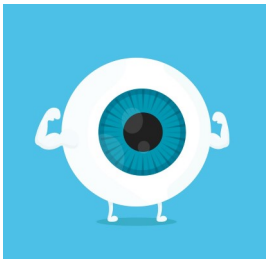

EXTRACT

Source: Group discussion NMDP

What is EXTRACT

Extract are the collections of some important points taken from the discussion in National MD Pharmacology group. NMDP is a group of eminent pharmacologists from all over the country. The head of departments of pharmacology, deans, directors of institutions and people with significant contribution in the field of pharmacology are members of NMDP family. National association of Pharmacology and Therapeutics is promoted by NMDP group.

 # NMC has updated phase wise academic calender and curriculum for 2022-2023 batch of MBBS: Teaching hours for Pharmacology have been increased from previous 230 hrs to 255 hrs. Lectures 80 hrs, Small group learning (tutorials/seminars)/Integrated learning 158 hrs and Self Directed Learning 17 hrs.

 # Propofol samples with sepsis causing bacterias and toxic impurities result in death of patients: An Internal committee was constituted in PGI to investigate death of the patients and it was found that Propofol was contaminated with sepsis causing bacteria and toxic impurities.

 # Delhi High Court Upholds NMC Regulations, Refuses to cap attempts of MBBS Prof Exams: Delhi High Court has dismissed the petitions challenging limited number of attempts to clear the first-year examination of MBBS course.

 # FDA approves first drug that can delay onset of Type I Diabetes: Tzield injection was approved by US FDA . It is an important new treatment option for certain at risk patients.

 # Extension to Clinical Trial Registry of India: Extension was given to CTRI, the repository of all data related to clinical trials taking place in India.

 # In Oct 2022 Drug Safety Alerts CDSCO flagged 59 medicine batches : CDSCO has flagged 59 medicines batches for failing to qualify a random drug sample test .

 # Amendment in NDCT Rules regarding registration of IEC: The registration of Ethics Committee shall be deemed to have been granted, provided that there was no communication from Central Licensing Authority within the period of 45 working days.

 # Hindi Version of first-year MBBS: Union Home Minister Amit Shah launched Hindi versions of first yesr MBBS books in Bhopal on October 16th.

 # FDA approves Terlivaz (Terlipressin) for the treatment of Hepatorenal syndrome: Terliv az for injection is the first and only FDA-approved rproduct indicated to improve kidney function in adults with Hepatorenal Syndrome.

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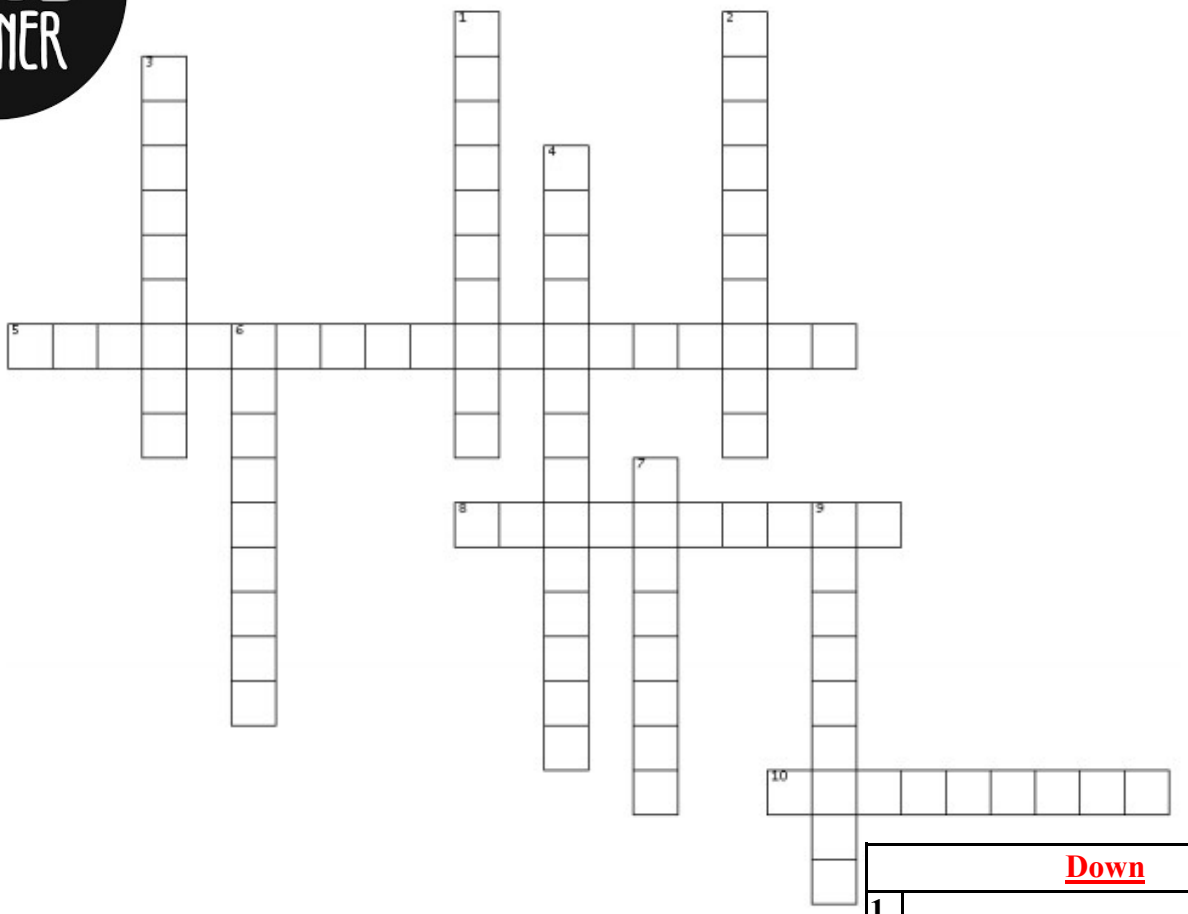
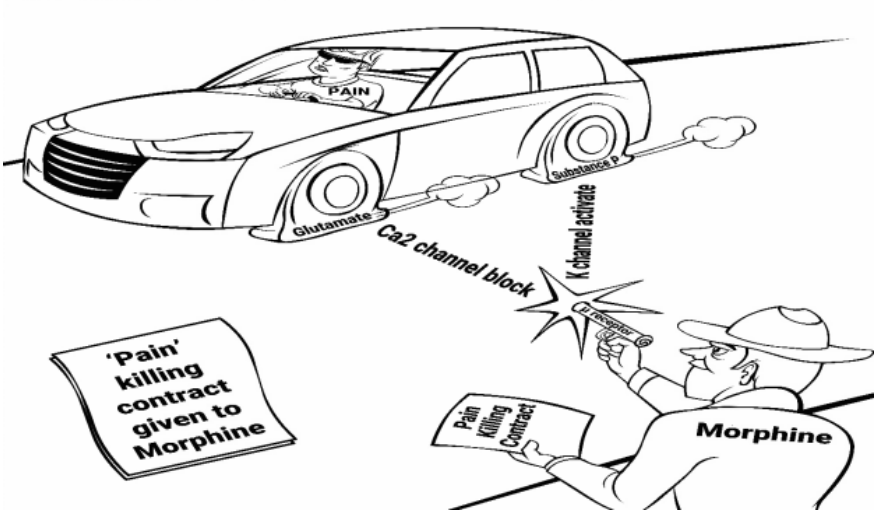


Across	
5	NO releasing Vasodilator
8	Potassium sparing diuretic with no hormonal side effects
10	Alpha 2 agonist that facilitates smoking cessation

Down	
1	Alpha 2 against used in pregnancy
2	Ankle oedema as an adverse effect
3	Alkaloid indigenous to India
4	Long acting thiazide diuretic
6	Also used in male pattern of bald-
7	Postural hypotension as a side
9	NO releasing Betablocker

Cartoon Corner



From the book: **"Drug Autobiographies in Pharmacology"** by Dr. Sushil Sharma

Answers for Crossword on next page

AMAZING DRUG MOLECULES: Drugs with Multiple Mechanisms

Some drug molecules exert their pharmacodynamic therapeutic actions by multiple mechanisms which is important to have broad spectrum of activity against pathophysiological clinical conditions.

Drug	Class	MECHANISM OF ACTION		Remark(s)
		Target		
Amiodarone	Antiarrhythmic	Na^+ Channel	Blockade	Broad Spectrum Antiarrhythmic Drug
		Ca^{2+} Channel	Blockade	
		K^+ Channel	Blockade	
		β Receptors	Antagonism	
Adenosine	Antiarrhythmic	Ca^{2+} Channel	Blockade	Broad Spectrum Antiarrhythmic Drug
		K^+ Channel	Blockade	
		β Receptor	Antagonism	
		A_1 Receptor	Agonism	
Propranolol	Antiarrhythmic	β Receptors	Antagonism	
		Na^+ Channel	Blockade	
Sotalol	Antiarrhythmic	β Receptors	Antagonism	
		K^+ Channel	Blockade	
Topiramate	Antiseizure	Na^+ Channel	Blockade	Broad Spectrum Antiseizure Drug
		Ca^{2+} Channel	Blockade	
		K^+ Channel	Opener	
		$GABA_A$ Receptor	Agonism	
		AMPA Receptor	Antagonism	
		KA Receptor	Antagonism	
		CA	Inhibition	
Valproic Acid	Antiseizure	Na^+ Channel	Blockade	Broad Spectrum Antiseizure Drug
		Ca^{2+} Channel	Blockade	
		$GABA_A$	Agonism	
		SSD	Inhibition	
Phenobarbitone	Antiseizure	$GABA_A$	Agonism	
		AMPA Receptor	Antagonism	
		KA Receptor	Antagonism	
Zonisamide	Antiseizure	Na^+ Channel	Blockade	Broad Spectrum Newer Generation Antiseizure Drug
		Ca^{2+} Channel	Blockade	
		CA	Inhibition	
Felbamate	Antiseizure	Na^+ Channel	Blockade	
		$GABA_A$	Agonism	
		NMDA Receptor	Antagonism	
Lamotrigine	Antiseizure	Na^+ Channel	Blockade	
		Ca^{2+} Channel	Blockade	
Carbamazepine	Antiseizure	Na^+ Channel	Blockade	
		$GABA_A$	Agonism	
Oxcarbazepine	Antiseizure	Na^+ Channel	Blockade	
		$GABA_A$	Agonism	

*CA: *Carbonic anhydrase*; SSD: *Succinic Semialdehyde Dehydrogenase*;

References:

Goodman and Gilman's The Pharmacological Basis of Therapeutics. 13th ed. New York: McGraw-Hill Education; 2018.

Harrison's Principles of Internal Medicine. 20th ed. New York: McGraw-Hill Education; 2018.

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Answers to Crossword

Q.No.	Across	Q.No.	Down
5.	Sodium Nitro-prusside	1.	Methyldopa
8.	Eplerenone	2.	Nifedipine
10.	Clonidine	3.	Reserpine
		4.	Chlorthalidone
		6.	Minoxidil
		7.	Prazosin
		9.	Nebivolol

NATIONAL ASSOCIATION OF PHARMACOLOGY AND THERAPEUTICS

Promoting Pharmacology and Therapeutics for a better tomorrow

www.nationalpharmacology.org

About the organization

A national organization of medical doctors specialized in pharmacology /clinical pharmacology and therapeutics. Envisaged to provide strong leadership to promote pharmacology and therapeutics for a better tomorrow. The association is fostered by NMDP (National MD Pharmacology), a prestigious group of eminent pharmacologists.

Aims and objectives

- Empowering medical doctors specialized in Pharmacology/Clinical Pharmacology and Therapeutics.
- Promoting academic and clinical research in Pharmacology/Clinical Pharmacology and Therapeutics.
- Enhancing the standard of teaching/training in Pharmacology/Clinical Pharmacology and Therapeutics
- Promoting Pharmacology/Clinical Pharmacology and Therapeutics for the benefit of patients and society.

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- Participate in general body meetings (GBM) to speak and to vote.
- Participate in conferences/seminars/workshops/symposiums/training sessions at subscribed charges.
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NATIONAL ASSOCIATION OF PHARMACOLOGY AND THERAPEUTICS

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