

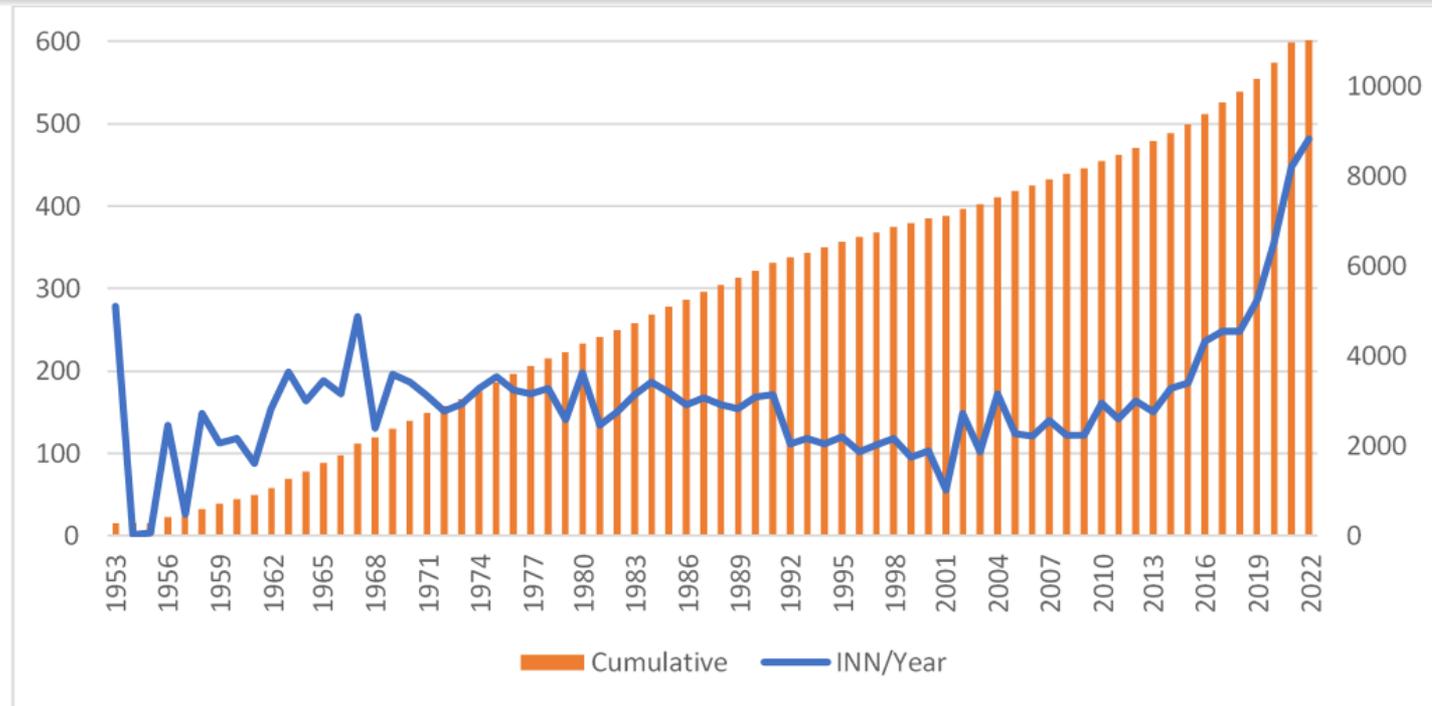
# School of INN (SoINN)

## INN in Education and Research



World Health  
Organization

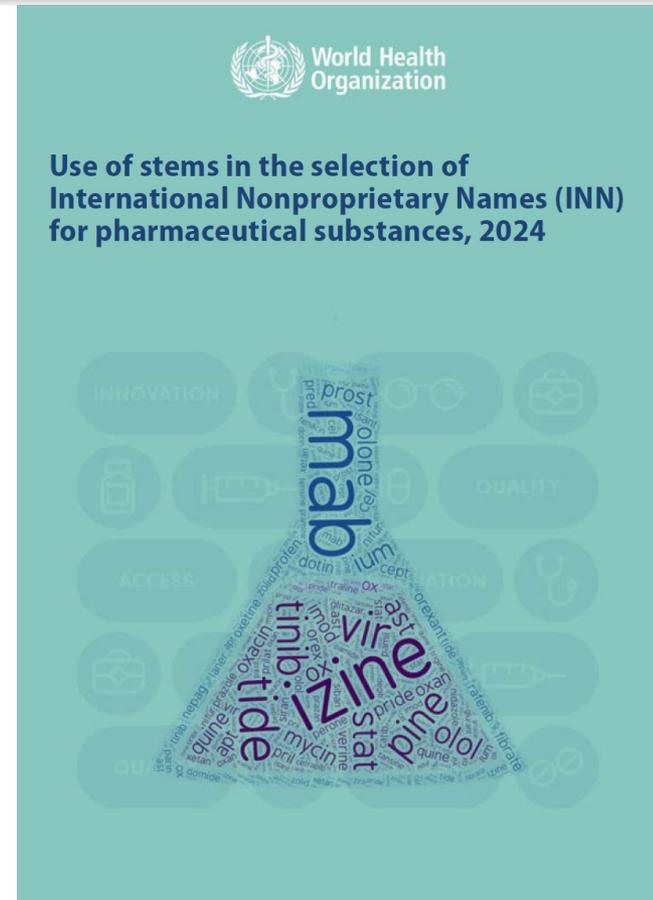
# INN since 1950



- 400 – 500 new INN pa; currently  $\pm$  14 000 pINN.
  - At least 50 % of new INN are for biological medicines
- 20 – 25 % of INN reach market
- 4 % of INN included in WHO Model list; 17 % in global EML

# The INN Stem

- Group medicinal substances according to:
  - Chemical structure
    - -ium for quaternary ammonium substances and
    - sulfa- for sulphonamide anti-infectives
  - Combination of pharmacology and chemical
    - fluconazole with -conazole indicating miconazole antifungal agents
  - Mechanism of action, pharmacological class or therapeutic use
    - camostat and captopril based on the mechanism of action;
    - praziquantel and pyrantel with -antel as stem for anthelmintics
    - cevimeline with -meline indicating that it is a cholinergic agent used in treatment of Alzheimer's disease



# Stem and Substem

- Groups or stems can also be subdivided by using substems:
  - -tinib (tyrosine kinase inhibitors)
    - -brutinib (Bruton tyrosine kinase inhibitors)
    - -citinib (Janus kinase inhibitors)
    - -metinib MEK (MAPK kinase) tyrosine kinase inhibitors
  - -vir (antivirals)
    - -previr (Hepatitis Virus C (HVC) protease inhibitors)
    - -tegravir (HIV integrase inhibitors) etc.
- For biological medicine like monoclonal antibodies, stems are also used in combination with specific infixes  
Tras-tu-zu-mab (old scheme)  
-tug, -bart, -ment and -mig (new scheme)

# School of INN

The vision of this SoINN is to have the INN used by all stakeholders across the world as a common nomenclature for all pharmaceutical substances.

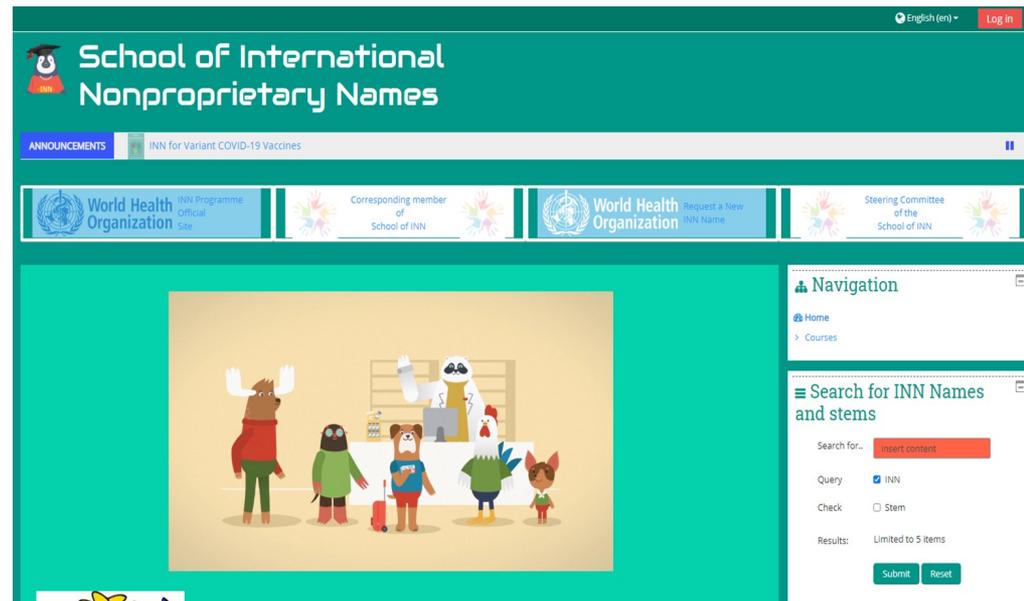


# SoINN Role and Function

- Virtual School
- Promote INN as central teaching and learning theme for all health professionals
  - Science of nomenclature and naming of pharmaceutical substances
- E-learning platforms and online courses
- Online resources and publications

<https://extranet.who.int/soinn/>

- Pilot sites and Collaborations



# Introduction to Drug Nomenclature and INN

## Introduction to Drug Nomenclature & International Nonproprietary Names for Pharmaceutical Substances



## Course Description

This short course will:

- Introduce the importance of nomenclature in science
- Introduce the origin of the International Nonproprietary Names (INNs) for pharmaceutical substances of the World Health Organization (WHO).
- Explain how a drug name is constructed based on scientific evidence and linguistic guidelines.
- Highlight where the INN is used or applied in
  - medicinal product regulation;
  - pharmaceutical marketing;
  - health workers education and
  - healthcare practices.

This module is composed of **5** short sections which can be viewed independently. Following each section is a short quiz for self-assessment.

School of INN  
Introduction to Drug Nomenclature &  
INN for Pharmaceutical Substances



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# INN and Biological Active Substances

## INN and Biological Active substances

- A. Introduction
- B. Proteins and other complex substances
- C. Monoclonal antibodies
- D. Advanced therapies



**New INN  
nomenclature  
for monoclonal  
antibodies**

Lancet Vol 399, 2  
022

# Example – Monoclonal Antibodies

## NAMING OF MONOCLONAL ANTIBODIES

The INN nomenclature scheme

Prefix + Substem A + Substem B  
(random) (target class) (species)

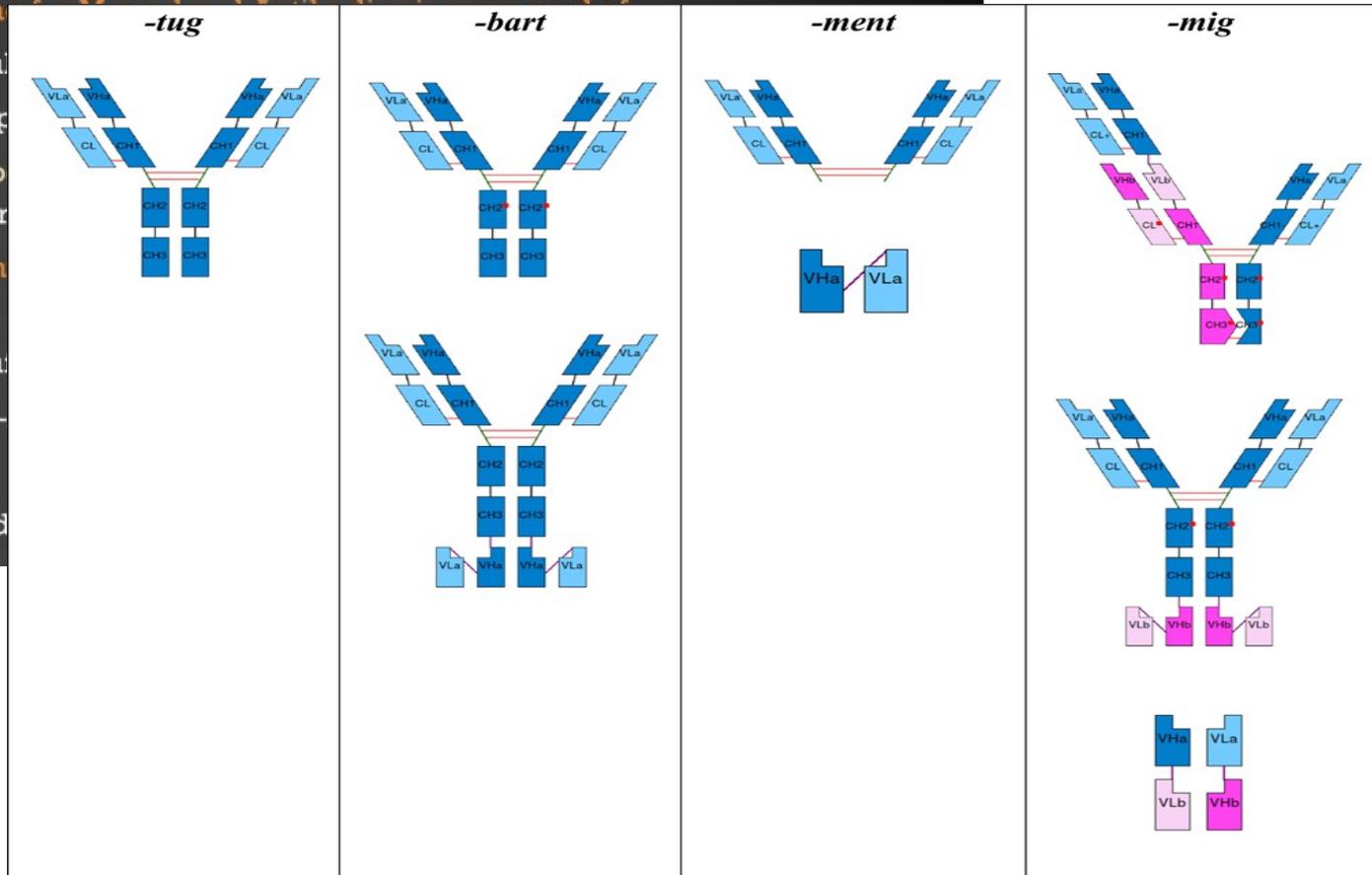
Example of Monoclonal Antibody  
**trastuzumab** (*tras-tu-zu-mab*: r

Following recent developments  
the species substem:

Prefix + Substem A + Substem B  
(random) (target class) (species)

Example:

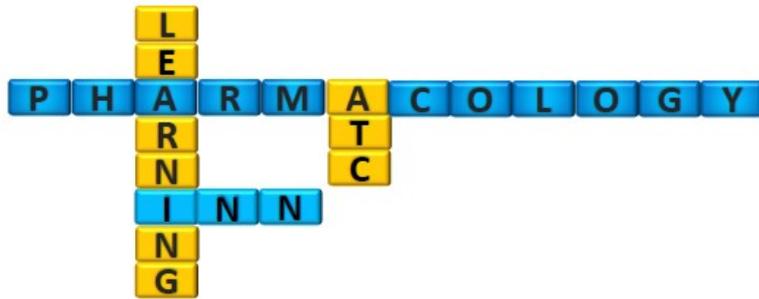
**netakimab** (*neta-ki-mab*: r



MABS, 2022, 14(1)  
e2075078

# Learning clinical pharmacology with the use of INN and their stems

First steps for **learning** Clinical Pharmacology.  
**ATC** classification. **INN** system



*“From molecular target to clinical patient effect”*

## Index:

1. **What** is the **ATC** classification
2. **What** is the **INN** system
3. **A** Alimentary tract and metabolism
4. **B** Blood and blood-forming organs
5. **C** Cardiovascular system
6. **D** Dermatologicals
7. **G** Genitourinary system and sex hormones
8. **H** Systemic hormonal preparations, excluding sex hormones and insulins
9. **J** Anti-infectives for systemic use
10. **L** Antineoplastic and immunomodulating agents
11. **M** Musculoskeletal system
12. **N** Nervous system
13. **P** Antiparasitic products, insecticides and repellents

# Chemical aspects considered in developing INN

## Chemical aspects considered in developing INN



## Learning Outcomes

At the end of the short course, participants will be able to:

1. Describe key chemical aspects contained in INN.
2. Identify and recognize INN using stems linked to chemical structure and/or mode of action.
3. Infer and correctly use prefixes, infixes and suffixes for indication of:
  1. stereochemistry
  2. deuteration
  3. phosphorylation, halogenation etc.
4. Relate the structural modification to the parent drug in its INN (International Nonproprietary Names Modified ).
5. Provide the correct graphic representation of pharmaceutical substances for publication of INN.

School of INN  
Chemical aspects considered in developing INN



# "Stem in a pill"

- Learning tool available in the School of INN.
  - Approach: Learning pharmacology utilizing stems as a common basis for the pharmacological action
  - Each topic contains information correlating INN and pharmacology
    - Medical substances in class
    - List of essential meds
    - Indications
    - Mechanism of action
    - Pharmacokinetics
    - Adverse reactions
    - Common contraindications
    - Warnings and precautions
    - Use in specific populations
    - interactions
    - Administration
    - Monitoring
    - Overdose
    - Important patient information
    - Related substances
    - Dosage forms
- WHO
- Drug

## Example: Beta adrenoreceptor antagonists (Beta blockers, BB)

- dilol – vasodilators; -lol - adrenoreceptor antagonists;
- alol - aromatic ring -CH-CH<sub>2</sub>-NH-R related to -lols

# Concluding Remarks

- INN are information rich
- Stem = MOA / pharmacological class
- School of INN (<https://extranet.who.int/soinn/>)
  - Valuable resource
    - School of INN; École des DCI; Escuela de DCI; مدرسة INN
    - Teaching
    - Information
      - INN and stem searches
      - Mednet
      - Publications
- Critical for every health professional, especially Pharmacists

# SoINN – Scholarship and Research

- Source of information
- Teaching and Learning
- Medication errors
- Access to medicines
- Medicinal Chemistry and Drug Design
- Information systems

# Source of Information

Prescrire Int. 2007 Oct;16(91):192.

## Common stems: international nonproprietary names (INNs): common INN stems provide key information

Prescrire Int. 2015 Jun;24(161):162-5.

## How INNs are created. Making drug names safer by contributing to INN selection

Review Prescrire Int. 2000 Dec;9(50):184-90.

## Think INN, prescribe INN, dispense INN: good professional practice

Vaccine 40 (2022) 21–27



The image shows the cover of the journal 'Vaccine'. On the left is the Elsevier logo, which features a tree and the text 'ELSEVIER'. In the center, it says 'Contents lists available at ScienceDirect' and 'Vaccine' in a large font. Below that, it provides the journal homepage: 'www.elsevier.com/locate/vaccine'. On the right is a small graphic of a green plant with the word 'Vaccine' above it.

Review

## International Nonproprietary Names (INN) for novel vaccine substances: A matter of safety



James S. Robertson<sup>a</sup>, Ursula Loizides<sup>b</sup>, Akinola Adisa<sup>c</sup>, Ana López de la Rica Manjavacas<sup>d</sup>, Vicente Rodilla<sup>e</sup>, Colette Strnadova<sup>f</sup>, Karin Weisser<sup>g</sup>, Raffaella Balocco<sup>b,\*</sup>

# Medication Errors

Drug Saf. 1995 Mar;12(3):155-60. doi: 10.2165/00002018-199512030-00001.

## Confusion over similar drug names. Problems and solutions

J K Aronson<sup>1</sup>

Look-alike sound-alike drug names may be responsible for as many as one in four error reports received by surveillance programs. ... confusion between trastuzumab and trastuzumab emtansine ...

... Nonproprietary names should be internationalized; ... Generic formulations should be marketed under their nonproprietary names, not new proprietary names.

WHO Drug Information Vol. 30, No. 1, 2016

Safety of medicines

Look-alike sound-alike drug name confusion:  
trastuzumab emtansine



tension between WHO guidelines stipulating use of stems to denote meaning, and the aim of reducing similarities in nomenclature. ... stem system should be made clear and well ordered ...

RESEARCH ARTICLE

Patient Safety in Medication Nomenclature: Orthographic and Semantic Properties of International Nonproprietary Names

Rachel Bryan<sup>1\*</sup>, Jeffrey K. Aronson<sup>2</sup>, Pius ten Hacken<sup>3</sup>, Alison Williams<sup>1</sup>, Sue Jordan<sup>1</sup>



# Access to Medicine

Access to NCD medicines: emergent issues during the COVID-19 pandemic and key structural factors

ISBN 978-92-4-006944-2 (electronic version)

ISBN 978-92-4-006945-9 (print version)

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API exports were identified by querying the database using the international nonproprietary name (INN) of each of the 13 medicines.

... savings without loss of benefit for patients, ... promote uptake of generics and biosimilars, ... prescribing by international non-proprietary names (INN)

OECD (2018), *Pharmaceutical Innovation and Access to Medicines*, OECD Health Policy Studies, OECD Publishing, Paris.

<https://doi.org/10.1787/9789264307391-en>

INN use indicated that patients would receive the cheapest therapeutic analogue available. As a downside, INN use for FDC medicine prescribing was associated with a higher ME risk.

# Medicinal Chemistry / Drug Design

Trends in Pharmacological Sciences

Volume 10, Issue 9, September 1989, Pages 349-354

Comment

Signs of the times: the need for a stereochemically informative generic name system

Miklós Simonyi<sup>1</sup>, Joseph Gal<sup>2</sup>, Bernard Testa<sup>3</sup>

... generic drug names often hide the fact that different stereoisomers may be present

Pharmaceutical Medicine (2020) 34:113–126  
<https://doi.org/10.1007/s40290-020-00325-0>

ORIGINAL RESEARCH ARTICLE



## Proposal for a New Stereochemically Informative Nonproprietary Drug Naming System

Joseph Gal<sup>1</sup>

Journal of  
**Medicinal  
Chemistry**

[pubs.acs.org/jmc](https://pubs.acs.org/jmc)

## What's in a Name? Drug Nomenclature and Medicinal Chemistry Trends using INN Publications

Marta Serafini,<sup>‡</sup> Sarah Cargini,<sup>‡</sup> Alberto Massarotti,<sup>‡</sup> Gian Cesare Tron, Tracey Pirali, and Armando A. Genazzani\*

Cite This: *J. Med. Chem.* 2021, 64, 4410–4429

Read Online

The stereochemical aspects of drugs are generally recognized as fundamentally important influencers of drug action and disposition. Nevertheless, the nonproprietary names ... provide no information on the stereochemical aspects.



Perspective

... some changes ... chemical structure, newer therapeutic targets (e.g., kinases), including a significant increase in the use of fluorine and of heterocycles, ... increase in molecular weight. .... rise in spirocyclic scaffolds and small rings and the emergence of unconventional structural moieties ...

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World Health  
Organization

QUALITY



ACCESS



QUALITY



ACCESS



QUALITY



QUALITY

QUALITY

# Information Systems and others

Drug Discov Today. 2008 Sep;13(17-18):816-23. doi: 10.1016/j.drudis.2008.06.001. Epub 2008 Jul 17.

**Drug name recognition and classification in biomedical texts. A case study outlining approaches underpinning automated systems**

Isabel Segura-Bedmar <sup>1</sup>, Paloma Martínez, María Segura-Bedmar

combines information from Unified Medical Language System (UMLS) MetaMapTransfer (MMTx) program and INN rules to identify and classify pharmaceutical substances. ... first step in a method for automatic detection of drug interactions

... dataset provides a resource for researchers, giving insights into trends in antibody engineering and a guide to the most frequently tested designs

MAbs. 2022 Jan-Dec;14(1):2123299. doi: 10.1080/19420862.2022.2123299.

**Systematic analysis of the varied designs of 819 therapeutic antibodies and Fc fusion proteins assigned international nonproprietary names**

Ian Wilkinson <sup>1</sup>, Geoff Hale <sup>1</sup>

**Disease foci of pharmaceutical research and development as reflected in applications for International Nonproprietary Names, 1953–2022**

Sarel F Malan,<sup>a</sup> Sophie AJ Lasseur,<sup>a</sup> Antonio Romeo<sup>a</sup> & Raffaella Balocco<sup>a</sup>

... medicine development for neglected tropical and other infectious diseases remains largely dependent on national policy, governmental and philanthropic funding, and partnerships. Better alignment of research and development strategy and investment in global medical needs is required.

# Learning and Teaching

*Pharmacy Education* (2022) 22(1) 73 - 76  
<https://doi.org/10.46542/pe.2022.221.7376>



## PROGRAMME DESCRIPTION

### **A pilot programme to teach pharmacology using the international nonproprietary names in a pharmacy school in Spain**

Conxita Mestres<sup>1</sup> , Marta Hernández Hernández<sup>1</sup> , Nilhan Uzman<sup>2</sup>, Màrius Duran<sup>1</sup> , Raffaella Balocco<sup>3</sup> 

... student's learning process was improved as a result of this methodology ...

WHO Drug Information, Vol. 35, No. 4, 2021

Pharmaceutical News

The INN is a global language that can contribute to the safety of patients. Understanding the construct of INN will be beneficial for learning and the application thereof in medicine.

**INTERNATIONAL NONPROPRIETARY NAMES:  
TRANSLATING THE SCIENCE OF NOMENCLATURE INTO A  
GLOBAL LANGUAGE FOR EDUCATION AND PRACTICE**

School of INN



World Health  
Organization

QUALITY

ACCESS

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# Concluding Remarks

- INN are information rich
- Stem = MOA / pharmacological class – Teaching and Learning
- Valuable resource
  - School of INN; École des DCI; Escuela de DCI; مدرسة INN
    - Teaching
    - Information
      - INN and stem searches
      - Mednet
      - Publications
- INN database – information and data
  - Scholarship of Learning
  - Research – medicine access; medication errors; drug design and trends in development.

*Thank you*  
*Gracias*

