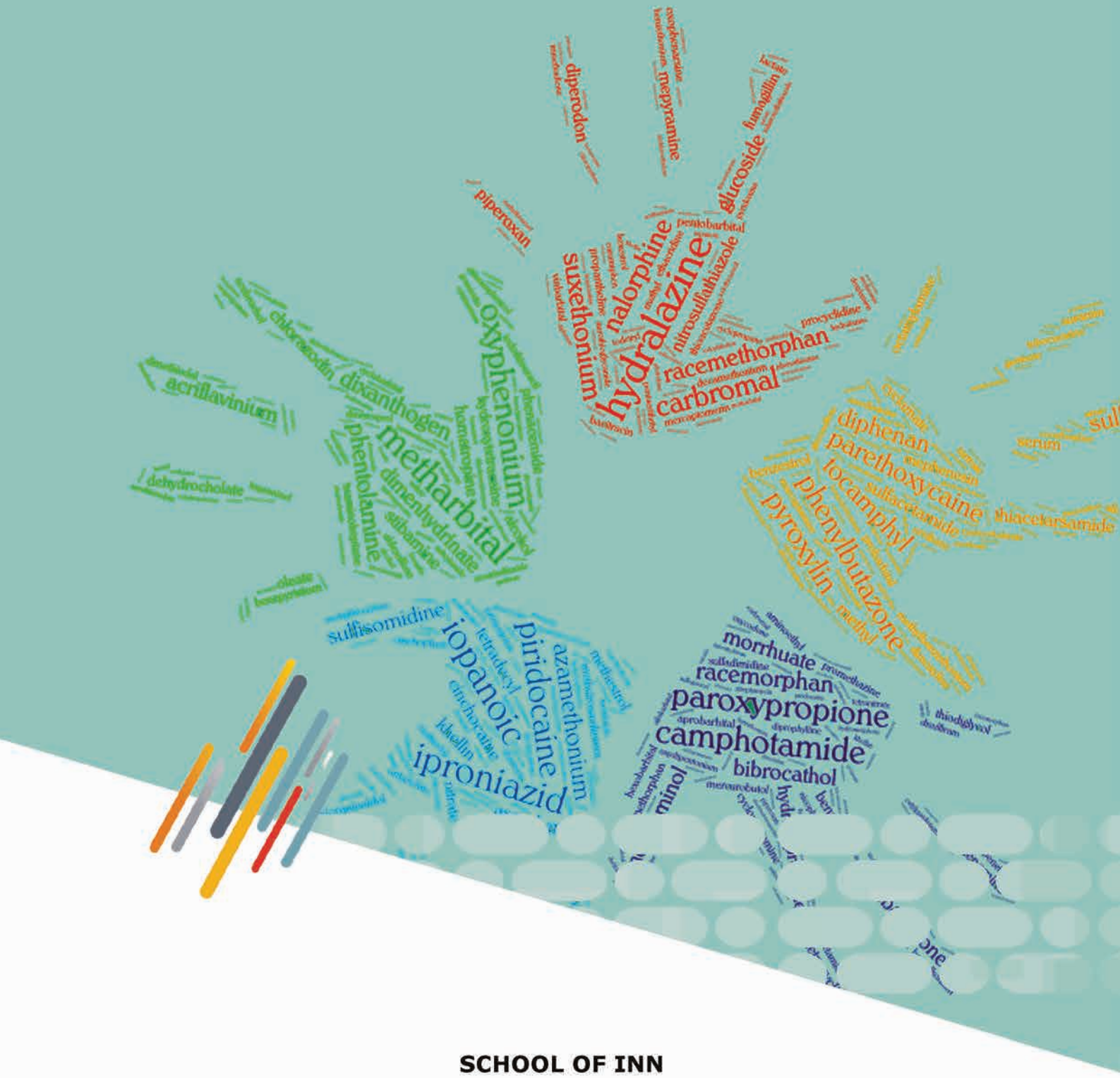

SCHOOL OF INN

Learning clinical pharmacology with the use of INNs and their stems

World Health Organization

School of INN

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WHO/EMP/RHT/TSN/2018.2

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Contents

TABLES

Any student who studies pharmacology and therapeutics will tell you that remembering the names of drug substances and their mechanisms of action is one of the most challenging tasks. Healthcare professionals also find it demanding to keep up with the names of new therapeutic agents. Knowing how to classify medicines in a systematic way and assisting healthcare professionals to select the most appropriate medicines for their patients is of utmost importance in ensuring efficacy and safety. Names of medicines come in different formats; there are chemical names, generic names and brand names. They are derived from different approaches and some are more practical than others in the clinic; but they all are intended to identify the active pharmaceutical ingredient. Patients, who are not technical experts of medicines, can find names confusing and may encounter risks, particularly in self-medication. For example, as the same active pharmaceutical ingredient can appear in different brands of a medicine, unknowingly the patient may consume the same active ingredient from different brands thus leading to drug overdose or toxicity. Therefore, protection of the patient against potential health risks is central to medicine nomenclature.

The International Non-proprietary Name (INN) Programme

The World Health Organization (WHO) has recognised and supported the importance of safety among users of medicines regardless of whether they are manufacturers, health professionals, patients or consumers. Therefore, WHO established The Programme on the International Nonproprietary Name (INN) for pharmaceutical substances in 1950 through resolution WHA3.11 of the World Health Assembly. This programme has been active since 1953. The main objective of setting up the INN Programme was to provide a unique single name for a pharmaceutical substance that is accepted globally. The INNs are intended to be used as public property without restraint. Since its inception, WHO has also taken the initiative in collaborating with national nomenclature organisations, pharmacopoeial commissions and regulatory agencies to harmonize the usage of the developed INNs. Recently, the INN Programme also opened its doors to frequent dialogue with the inventors and manufacturers of pharmaceutical substances while feedback from health professional organizations, patient advocates and consumer organizations are valued and considered in the naming process. All this is done in an effort to raise more awareness of the INN system as well as to strengthen the advocacy of ensuring patient safety.

The Science of Drug Nomenclature

The development of INN has evolved with time; new approaches and additional guidelines are continuously being included in the process of creating unique names for pharmaceutical substances. The naming of medicines is an evidence-based process and indeed it is part and parcel of evidence-based medicine. The science behind drug nomenclature has advanced over the years with the advent of better analytical techniques for identification and purity verification. With the introduction of biotechnological methods that are used in the manufacture of biologics and other biomedical treatments, the characterization of biologicals has become more precise and unambiguous. All these new advancements have underpinned the development of more sophisticated chemical and biological therapeutics and with this advances, the naming of new pharmaceutical substance candidates has become more complex and challenging.

In the early years of the INN Programme, modification of the chemical name was an acceptable approach to create the INN. As more pharmaceutical substances were being discovered and many of them shared similar chemical structures, although the mode of actions could be different, this approach eventually was superseded by other methods. Moreover, structural information was less informative or useful for the prescribers and dispensers. Gradually, with the discovery of more targets and with new medicines continuously being designed and used clinically, a move to using the mode of action to name the newer pharmaceutical substances became more prevalent. This mode of action became linked to a specific 'stem'.

What is a stem?

An INN typically begins with a random prefix, possibly followed by one or more infixes/substems and terminates with a suffix/stem. INN can also consist of more than one word. The stem, that usually coincides with the suffix, could also in principle be a different part of the word. A stem is a syllable (or 2-3 syllables) to indicate the pharmacological relationship and is developed based on three criteria, the mode of action, and/or the clinical use, and the structure. The purpose of the stem is to group medicines that have similar therapeutic use or clinical action, this minimises the co-use of similar medicines which would increase adverse reactions, and facilitates the use of an alternative medicines when one becomes ineffective. Stems usually coincide with the suffix but can in principle appear in a different part of the word. Every two years the INN Programme publishes a document containing extensive information about the INN stem system and the complete WHO stem book: "The use of stems in the Selection of International Nonproprietary Names for Pharmaceutical Substances", which is complemented twice a year, after each INN Consultation, by an Addendum.

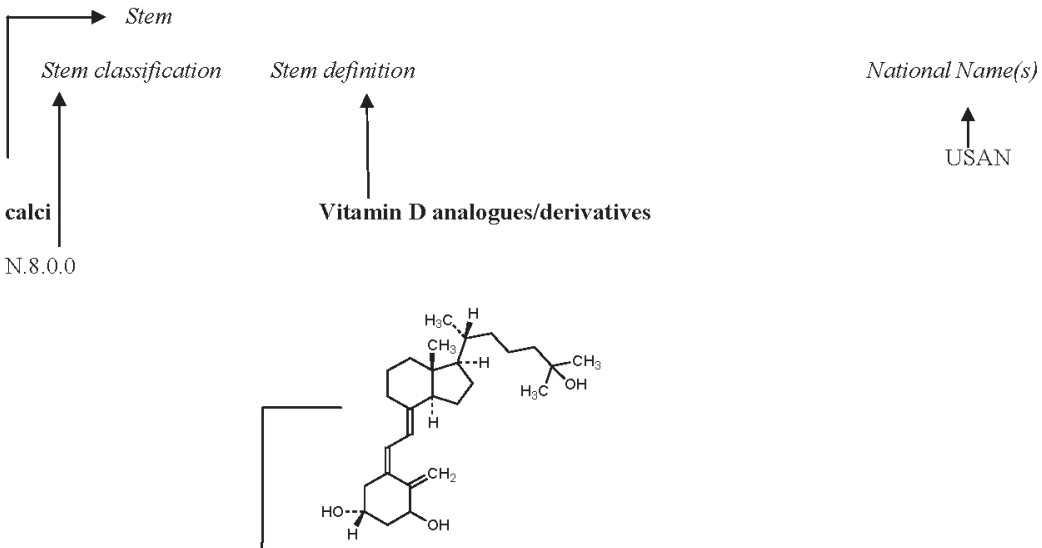
Thus the stem in the INN is a guide towards the mode of action or pharmacological class and defines the pharmacologically related group to which the INN belongs. Stems and their definitions have been selected by WHO experts and are used when selecting new INNs. As the nomenclature process is on-going and constantly under revision, the definitions of older stems are modified as and when newer information becomes available. Whenever possible, an INN should include an established stem expressing the pharmacologically-related group to which the substance belongs. Names that are likely to convey an anatomical, physiological, pathological or therapeutic suggestion are avoided. It should be highlighted that INNs are issued before a drug is marketed and typically even before it has completed its clinical development. It may therefore occur, in particular instances, that the INN reflects the knowledge at the time of its issuance, but which may have been surpassed when the drug arrives on the market.

For each stem, INNs in the WHO stem book are classified as (a), (b) or (c) where:

a. INNs in which the preferred stem has been used in accordance with its definition;
b. INNs in which the preferred stem has been used, but not in accordance with its definition;
c. INNs which belong to the same group of pharmaceutical substances but in which the preferred stem has not been used. (This part of the list is not exhaustive).

Sometimes sub-stems are established to differentiate between different related groups of substances.

Layout of information



(a) alfacalcidol (40), calcifediol (26), calcipotriol (61), calcitriol (39),

colecalciferol (13), doxercalciferol (82), ergocalciferol (13),

falecalcitriol (74), lexacalcitol (71), maxacalcitol (75), paricalcitol (78), secalciferol (62), seocalcitol (78), tacalcitol (65)

(b) calcitonin (31) (polypeptide)

(c) dihydrotachysterol (1)

Graphic Formula *INN (English)*

List of proposed INN

Names in which the preferred stem has been used in accordance with its definition

Names in which the preferred stem has been used but not in accordance with its definition

Names which belong to the same group of pharmaceutical substances and in which no preferred stem has been used (this part of the list is not exhaustive)

(x) stems that are included in article 9 of the General Principles

(d) stems that were formerly used but are no longer formally acknowledged by the INN Programme.

The Use of INN and their stems in Education

As demonstrated, the INNs are constructed with evidence provided by the inventors and the unique name of each pharmaceutical substance also carries with it the information on the chemistry, pharmacology, and/ or the potential use of the substance as supplied by the applicant. It is therefore appropriate and useful to introduce students to the INN system as the names are information-rich and students are likely learn better by making an association with stems rather than memorizing by rote.

A stem is useful for teaching pharmacology if two conditions are met:

1. Within a given pharmacological class, most pharmaceutical substances have a common stem.
2. This stem is specific for a given pharmacological class. For example, the *-tide* stem (for peptides) is not useful for teaching purposes, because pharmaceutical substances with INNs ending in *–tide* can belong to very different pharmacological classes. In contrast, the *–begron* stem is useful because it is highly specific for $beta_3$ adrenoreceptor agonists.

The ATC classification

Pharmacology textbooks are structured with chapters devoted to anatomical systems, disorders or drug classes. In the present handout, we set to use the ATC classification of drugs established by the WHO Collaborating Centre for Drug Statistics Methodology. In this classification, drugs are classified in groups at five different levels. The drugs are divided into fourteen main groups (1st level), with pharmacological/therapeutic subgroups (2nd level). The 3rd and 4th levels are chemical/pharmacological/therapeutic subgroups and the 5th level is the chemical substance.

The complete classification of metformin (A10BA02) illustrates the structure of the code:

A Alimentary tract and metabolism
(1st level, anatomical main group)
A10 Drugs used in diabetes
(2nd level, therapeutic subgroup)
A10B Blood glucose lowering drugs, excl. insulins
(3rd level, pharmacological subgroup)
A10BA Biguanides
(4th level, chemical subgroup)
A10BA02 metformin
(5th level, chemical substance)

Thus, in the ATC system all plain metformin preparations are given the code A10BA02. This code is indicated in the Summary of Product Characteristics for each medicine approved for marketing in Europe and USA. While students may not necessarily be familiar with the system, it will help classification of drugs and will generally follow the textbook

structure, as the first level represents the anatomical level and the second will represent the disorder.

The 14 main groups of the ATC classification (1st level) are as follows:

- **A Alimentary tract and metabolism**
- **B Blood and blood-forming organs**
- **C Cardiovascular system**
- **D Dermatologicals**
- **G Genitourinary system and sex hormones**
- **H Systemic hormonal preparations, excluding sex hormones and insulins**
- **J Anti-infectives for systemic use**
- **L Antineoplastic and immunomodulating agents**
- **M Musculoskeletal system**
- **N Nervous system**
- **P Antiparasitic products, insecticides and repellents**
- **R Respiratory system**
- **S Sensory organs**
- **V Various**

In the WHO stem book, the definition of a pharmacological class is not unequivocal. Depending on the context, pharmaceutical substances are grouped together by their:

- Mechanism of action (e.g. beta-blockers, aromatase inhibitors).
- Active ingredient or chemical class (e.g. opioids, corticosteroids).
- Intended action (e.g. diuretic, analgesic, antipsychotic or antibiotic)

Methodology

This document aims to show in concrete terms how INN stems can be integrated into a pharmacology textbook.

The text was developed as follows:

- Pharmacological classes in each ATC group were listed as defined by ATC classification, ignoring isolated drugs that do not belong to any class, therapeutic subgroups (2nd level), pharmacological subgroups (3rd level) and chemical subgroups (4th level) that include only substance associations and subgroups for which active substances are already presented in other sections.

  For example group A-*Alimentary tract and metabolism* begins with therapeutic subgroup A02 *Drugs for acid related disorders* and ignores A01 *Stomatological preparations* (for example some antiinfectives, antiseptics are included in stomatological preparations but are treated in Chapter J *Anti-infectives*).

- Stems corresponding to each pharmacological subgroup were identified.
- The number of INNs listed in the WHO stems book that belong to the relevant pharmacological class and possess the appropriate stem (designated (a) according to WHO stems book) were determined.
- INNs listed in the WHO stem book that possessed the stem in question but did not belong to the corresponding pharmacological class (designated (b) according to WHO stems book) were cited.
- INNs listed in the WHO stems book that belonged to the pharmacological class in question but did not contain the stem (or sometimes contained another stem) (designated (c) according to WHO stems book) are cited.

Ideally, all pharmaceutical substances with a given stem should belong to the same pharmacological class, and all INNs for pharmaceutical substances belonging to this class should possess the stem in question, thus (a): x INNs, (b): 0 INN, (c): 0 INN) according to the WHO stem book. This would guarantee that all substances with an INN containing a given stem would belong to the same pharmacological class, and that all substances belonging to this class would possess this stem in their INN.

The situation [(a): x INNs, (b): 0 INN, (c): y INNs] is also acceptable, as it indicates that all pharmaceutical substances with a given stem in their INN belong to the same pharmacological class, but that care should be taken because some substances belonging to this class do not possess the relevant stem.

The situation [(a): x INNs, (b): z INNs, (c): y INNs] is the most difficult. In addition to the limitations of the previous situation, it indicates that certain pharmaceutical substances with the given stem actually belong to another pharmacologic class. It is important to provide a list of these INNs taken from the WHO stem book. Overall, the value of stems for pharmacology teaching depends on the x:z ratio: the lower the ratio, the less useful the stem.

This document takes into account all the INNs listed in the WHO database in 2013 and most recent Addendum (08/07/2016 version). Some of these medicines have never been marketed or are no longer available. We therefore searched the regularly updated clinical pharmacology reference website www.medicinescomplete.com/mc/martindale for all the INNs classified as (b) or (c) in the WHO stem book. We considered that if this website did not contain a monograph for an INN, the medicines was very unlikely to have been marketed and could therefore be omitted from this guide.

Using stems to learn pharmacology is especially important for essential medicines. Therefore, for each stem we indicated if a drug of the 20th WHO model list of essential medicines was concerned. In the opposite case, to give an example of an INN concerned by the stem, we have chosen, for the sake of impartiality, to indicate for which INN this stem had been used for the first time. Please note that the exemplified drug might not be the most representative and, in particular instances, may not have reached the market

This is a guide to be used in combination with pharmacology text books and is not intended to provide an in-depth clinical pharmacology education. It simply aims to offer students a few pointers to help them tackle this complex science. For some stems, some

examples of common properties for INNs including these stems are proposed to show the interest of these stems in clinical practice. For example, for anti-inflammatories, their gastric toxicity and their absolute contraindication during pregnancy are stated. The properties highlighted in this guide are described in standard clinical pharmacology sources. Students will still need to read these sources, since our selection is based on personal view of a restricted grop of INN experts Nevertheless, it is considered that associating specific stems with a few keywords can be useful to students and help them acquire reflexes that will be useful in their clinical practice.

ALIMENTARY TRACT AND METABOLISM

A02 DRUGS FOR ACID RELATED DISORDERS

A02A Antiacids

The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

A02B Drugs for peptic ulcer and gastro-oesophageal reflux disease (GORD)

A02BA H_2-receptor antagonists

Stem *–tidine* is used for "Histamine H_2 receptor antagonists, cimetidine derivatives"

All INNs with this stem belong to this pharmacological class except for *azacitidine* (antineoplastic) and *hexetidine* (disinfectant). *Ranitidine* (WHO Model List of Essential Medicines) belongs to this class.

Some common properties: *Cimetidine* and other H_2-antagonists can reduce the absorption of drugs whose absorption is dependent on an acid gastric pH.

A02BB Prostaglandins

Stem *–prostil* is used for "prostaglandins, anti-ulcer"

All INNs with this stem belong to this pharmacological class. It was used the first time for *deprostil*

Some properties: Prostaglandins are numerous and involved in many biological processes. Chemically very close prostaglandins can have very different properties. For example, *misoprostol* induces both uterine contractions and inhibits gastric secretion. It is used in gynaecology and gastroenterology. Other prostaglandins are used for their vasodilator properties in glaucoma and erectile dysfunction.

A02BC Proton pump inhibitors

Stem *–prazole* is used for "antiulcer, benzimidazole derivatives"

All INNs with this stem belong to this pharmacological class. *Omeprazole* (WHO Model List of Essential Medicines) belong to this class.

Caution: Stem *–piprazole* is used for "psychotropics,phenylpiperazine derivatives"

Examples of common properties *Omeprazole* and other proton pump inhibitors are metabolised by the cytochrome P450 system. *Omeprazole* and other proton pump inhibitors can affect the absorption of drugs whose absorption is dependent on an acid gastric pH. So it is important to consider chapter "interactions" for these drugs.

- ***A03 DRUGS FOR FUNCTIONAL GASTROINTESTINAL DISORDERS***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A04 ANTIEMETICS AND ANTINAUSEANTS***

- ***A04A Antinauseants and anti-emetic agents***

- ***A04AA Serotonin (5-HT3) receptor antagonists***

  Stem *–setron* is used for "serotonin receptor antagonists (5-HT3) not fitting into other established groups of serotonin receptor antagonists

  All INNs with this stem belong to this pharmacological class. For example, it is the case for *ondansetron* (WHO Model List of Essential Medicines).

- ***A04AD Other antiemetics***

  Substance P receptor antagonists

  Stem *–pitant* is used for "neurokinin NK1 (substance P) receptor antagonists"

  All INNs with this stem belong to this pharmacological class. This stem was used the first time for *dapitant*

  Anticholinergics

  No specific stem.

  Antihistamines which are often used as antiemetics, are classified in R06 *–Antihistamines for systemic use.*

  Butyrophenones

  Stem *–peridol* is used for "antipsychotics, haloperidol derivatives" and it is not possible to differentiate some of them used only as anti-emetics

  Phenothiazines

  There is no common stem for phenothiazines

  Steroids

  There is no stem for identifying steroids used only as anti-emetics

- ***A05 BILE AND LIVER THERAPY***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A06 DRUGS FOR CONSTIPATION***

  Laxatives, cathartics

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A07 ANTIDIARRHEALS, INTESTINAL ANTIINFLAMMATORY/ ANTIINFECTIVE AGENTS***

- ***A07A Intestinal antiinfectives.***

  This group comprises locally acting antiinfectives like *paronomycin* (WHO Model List of Essential Medicines). Antiinfectives for systemic use, see J- *Antiinfectives for systemic use.*

- ***A07B Intestinal adsorbents***

  Used medicines are combinations with intestinal antiinfectives.

- ***A07C Electrolytes with carbohydrates*** **No medicine with INN**

- ***A07D Antipropulsives***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A07E Intestinal anti-inflammatory agents***

  Mesalazine (5-ASA) – based therapy

  Stem *–salazine/salazide* No definition

  All INNs with this stem belong to this pharmacological class. *sulfasalazine* (WHO model list of essential medicines) belongs to this class.

  Thiopurine derivatives

  No specific stem useful for teaching pharmacological properties.

  Biological therapy

  No specific stem useful for teaching pharmacological properties.

- ***A07F Antidiarrheal microrganisms***

  No medicine with INN.

- ***A08 ANTIOBESITY PREPARATIONS, EXCL. DIET PRODUCTS***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A09 DIGESTIVES, INCL. ENZYMES***

  Stem *–ase* used for "enzymes" is not useful because it is not specific

- ***A10 DRUGS USED IN DIABETES***

- ***A10A Insulin and analogues***

  These medicines contain the name insulin + a second name

- ***A10B Blood glucose lowering drugs, excl. insulins***

- ***A10BA Biguanides***

  Stem –*formin* is used for "antihyperglycaemics, phenformin derivatives.

  All INNs with this stem belong to this pharmacological class also named "biguanides. *Metformin* (WHO Model List of Essential Medicines) is the only member of the biguanide class available for use today.

- ***A10BB Sulfonamides, urea derivatives (also called Sulfonylureas first generation)***

  No useful stem but these drugs are no more in use

- ***A10BC Sulfonamides (heterocyclics) (Also called Sulfonylureas second generation)***

  Stem *gli* (previously gly) is used for "antihyperglycaemics" but it is not specific for sulfonylureas second generation. *gliclazide* (WHO model list of essential medicines) belongs to this class

- ***A10BD Combinations of oral blood glucose lowering drugs***

  All components of these combinations have their own INN.

- ***A10BF Alpha glucosidase inhibitors***

  Pharmaceutical substances in this class like *acarbose, miglitol* do not have a common stem.

- ***A10BG Thiazolinediones***

  Stem –*glitazone* is used for "peroxisome proliferator activating receptor gamma agonists, thiazolinedione derivatives"

  All INNs with this stem belong to this pharmaceutical class. This stem was used the first time for *ciglitazone.*

  Examples of common properties Glitazones reduce insulin resistance in type 2 diabetes. Some had to be withdrawn from the market because of serious side effects.

- ***A10BH Dipeptyl peptidase 4 (DPP-4) inhibitors***

  Stem –*gliptin* is used for "*dipeptidyl aminopeptidase –IV inhibitors*"

  All INNs with this stem belong to this pharmaceutical class. This stem was used the first time for *saxagliptin.*

  Examples of common properties Some adverse effects of gliptins which are incretin catabolism inhibitors are common with *exenatide* or *liraglutide* which are GLP-1 agonists. GLP-1 is a hormone of the incretin family.

A10BX Other blood glucose lowering drugs, excl insulins

GLP-1 agonists

GLP-1 agonists, like *exenatide* and *liraglutide* are peptides with Stem –tide very imprecise.

Ampk and PPAR gamma activators

Stem –*glitazar* is for "peroxisome proliferator activating receptor gamma (PPAR-gamma) agonists"

All INNs with this stem belong to this pharmaceutical class. This stem was used the first time for *farglitazar.*

Stem –*gliflozin* is used for "sodium glucose co-transporter inhibitors, phlorizin derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *dapagliflozin.*

Examples of common properties Gliflozins increase the excretion of glucose in the urine. They expose to a risk of urinary and genital infections

A11 VITAMINS

Stem *calci* is for "vitamin D analogues derivatives"

Calcitonin does not belong to this pharmacological class.

A12 MINERAL SUPPLEMENTS

No INN.

A13 TONICS

In general mixtures with no INN.

A14 ANABOLIC AGENTS FOR SYSTEMIC USE

A14A ANABOLIC STEROIDS

Anabolic steroids used exclusively in cancer therapy, see L-Antineoplastic and immunomodulating agents.

BLOOD AND BLOOD FORMING ORGANS

▪ *B01 ANTITHROMBOTIC AGENTS*

▪ *B01AA Vitamin K antagonists*

Stem –*arol* I used for "anticoagulants, dicoumarol derivatives"

6 INNs with this stem belong to this pharmacological class but we have also 5 INNs that belong to this class without this stem, for example, *warfarin* (WHO Model List of Essential Medicines), *phenprocoumon*. This stem was used the first time for *acenocoumarol*.

Examples of common properties The anticoagulant effect of antivitamin K is monitored by a blood test, the INR (International Normalized Ratio). Vitamin K antagonists are metabolized by Cyt P450. Risk of pharmacokinetic interactions is important.

▪ *B01AB Heparin group*

Stems –*parin* is used for "heparin derivatives including low molecular mass heparins"

All INNs with this stem belong to this pharmaceutical class. *enoxaparin* (WHO Model List of Essential Medicines) belongs to this group.

Examples of common properties There are two types of heparin thrombocytopenia. Moderate thrombocytopenia type I, which occurs within the first 5 days of treatment, and type II thrombocytopenia, severe, associated with thrombosis. Platelet monitoring is recommended during heparin therapy.

The activity of the unfractionated heparins is measured by the partial thromboplastin time with activator. Protamine sulphate quickly neutralizes their anticoagulant effect. The activity of low molecular weight heparins is monitored by anti Xa activity

Others parenteral anticoagulants

Stem –*irudin* is used for "hirudin derivatives"

All INNs with this stem belong to this pharmacological group. This stem was used the first time for *desirudin.*

Example of common properties: *desirudin* and *lepirudin* are used for treating thrombosis in the setting of heparin induced thrombocytopenia.

Stem –*troban* is used for "thromboxane A_2- receptor antagonists; antithrombotic agents"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *sulotroban*.

Example of common properties: *argatroban* and others can be used for patients with or at risk of developing heparin induced thrombocytopenia.

Stem –*cogin* is used for "blood coagulation cascade inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *tifacogin*.

When selecting an anticoagulant, it is important to consider if tests to evaluate anticoagulant effect exist and if antagonists are available in case of haemorrhage.

▪ *B01AC Platelet aggregation inhibitors excl. heparin*

Stem –*grel* is used for "platelet aggregation inhibitors"

All INNs with this stem belong to this pharmacological class. *Clopidogrel* (WHO model list of essential medicines) belongs to this group.

Stem –*pafant* is used for "platelet-activating factor antagonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *apafant* and *bepafant*.

Interactions: Concommitant administration with an anticoagulant or non steroidal anti-inflammatory drug increases the risk of bleeding.

▪ *B01AE Direct thrombin inhibitors*

Stem –*gatran* is used for "thrombin inhibitors, antithrombotic agents"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *efegatran*.

Examples of common properties: There is no test to monitor coagulation. *Idarucizumab* is an antidote for *dabigatran*.

▪ *B01AF Direct factor Xa inhibitors*

Stem –*xaban* is used for "blood coagulation factor X_A inhibitors, antithrombotics"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *otamixaban*.

Examples of common properties There is no test to monitor coagulation or antidote for overdose.

▪ *B01AX Other antithrombotic agents*

Stem –*fiban* is used for "fibrinogen receptor antagonists (glycoprotein IIb/IIIa receptor antagonists").

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *lamifiban*.

Example of common properties: The major risk is bleeding and they may induce thrombocytopenia.

▪ *B02 ANTIHEMORRHAGICS*

Stem –*cog* is used for "coagulation factors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *moroctocog alfa*.

▪ *B03 ANTIANEMIC PREPARATIONS*

Stem –*poetin* is for "erythropoietin type blood factors

All INNs with this stem belong to this pharmacological class. This stem was used first time for *epoetin alfa*.

CARDIOVASCULAR SYSTEM

▪ *C01 CARDIAC THERAPY*

▪ *C01B Anti-arrhythmic, class I and III*

Stem –*afenone* is used for "Antiarrhythmics, propafenone derivatives"

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *etafenone*.

Stem –*aj*- is used for "antiarrhythmics, ajmaline derivatives

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *prajmalium bitartrate*.

Stem –*cain*- is used for "Class I antiarrhytmics"

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *bucainide*.

Stem –*ilide* is used for "class III antiarrhythmics, sematilide derivatives"

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *sematilide*.

Stem –*isomide* is used for "class I antiarrythmics disopyramide derivatives"

All INNS with this stem belong to this pharmacological class. This stem was used the first time for *pentisomide*.

Stem –*kalant* is used for "potassium channel blockers"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *almokalant*.

Examples of common properties: Antiarrhythmics (formerly described as cardiac depressants) are a diverse group of drugs that affect the conduction of electrical impulses within the heart. Many of them, have important actions in addition to their antiarrhythmic properties and thus, have a wide range of other clinical applications.

The most widely used classification of antiarrhythmics is that proposed by Vaughan Williams (later modified by Harrison) and is based largely on their *in-vitro* electrophysiological effects. A major limitation of the Vaughan Williams classification is that many antiarrhythmics have multiple actions, and may not fit neatly into a single class.

All antiarrhythmics have major cardiac side effects and many interactions.

▪ *C01C Cardiac stimulants excl. cardiac glycosides*

Stem –*rinone* is used for "cardiac stimulants, amrinone derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *amrinone*.

Stem –*dan* is for "cardiac stimulants, pimobendan derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *pimobendan.*

Example of common properties: Increased risk of arrhythmia and death are likely related to the PDE3 inhibitor effect of these substances.

▪ *C01D Vasodilators used in cardiac diseases*

Stem –*afil* is sed for "inhibitors of phosphodiesterase PDE5 with vasodilator action"

All INN with this stem belong to this pharmacological class. This stem was used the first time for *sildenafil.*

Examples of common properties PDE5 inhibitors have mainly cardiovascular and visual adverse effects. They expose to many pharmacokinetic interactions

▪ *C01EB other cardiac preparations*

Stem –*bradine* is used for "bradycardic agents"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *zatebradine.*

▪ *C02 ANTIHYPERTENSIVES*

Alpha$_1$ adrenergic receptor antagonists

Stem –*azosin* is used for "antihypertensive substances, prazosin derivatives"

All INNs with this stem belong to this pharmacologic class that also includes: *alfluzosin, tamsulosin*, *tipentosin*.

Example of common properties: Alpha-1 blockers are not recommended as montheray for hypertensive patients. They are attractive drugs for hypertensive patients with benign prostate hyperplasia because they also improve urinary symptoms.

Alpha$_2$ adrenoreceptor antagonists

INNs for these medicines have no common stem

Non selective alpha adrenergic antagonists

INNs in these medicines have no common stem.

Guanidine derivatives

Stem –*guan*- is for "antihypertensives, guanidine derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used first time for *guanethidine.*

Hydralazine

Stem –*dralazine* is used for "antihypertensives, hydralazine phtalazine derivatives"

All INNs with this stem belong to this pharmacological class. *hydralazine* (WHO Model List of Essential Medicines) belongs to this class.

Example of common properties: Many cardiovascular side effects linked to mechanism of action. These substances may induce immunological reaction like lupus syndrome.

Stem –*kalim* is used for "potassium channel activators, antihypertensive"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *cromakalim*.

C02KX Other antihypertensives

Stem –*ciguat* is for "guanylate cyclase activators and stimulators"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *ataciguat* and *atriciguat*.

Stem –*entan* is used for "endothelin receptor antagonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *bosentan*.

▪ *C03 DIURETICS*

Inhibitors of carbonic anhydrase

INNs for these medicines have no common stem.

Warning: Carbonic anhydrase inhibitors such as *acetazolamide* are weak diuretics and are used mainly to reduce intra-ocular pressure in glaucoma

Osmotic diuretics

INNs for these medicines have no common stems.

Osmotic diuretics raise the osmolality of plasma and renal tubular fluid. They are used to reduce or prevent cerebral oedema, to reduce raised intra-ocular pressure, and in acute renal failure.

Inhibitors of Na^+ - K^+ - $2Cl^-$ symport (loop diuretics, high-ceiling diuretics)

Stem –*etanide* is for "diuretics (peritanide type)"

All INNs with this stem belong to this pharmacological class. Tis stem was used first time for *bumetanide*.

Stem –*semide* is for "diuretics, furosemide derivatives"

All INNS with this stem belong to this pharmacological class. This stem was used first time for *furosemide*.

Stem –*pamide* is for "diuretics, sulfamoylbenzoic acid derivatives"

This stem is not specific for this pharmacological class

Inhibitors of Na^+ - Cl^- symport (thiazide and thiazide like diuretics)

Stem –*tizide* is for "diuretics, chlorothiazide derivatives"

All INNs with this stem belongs to this class. Also14 INNs drugs end by –*thiazide* and belong to this class like *hydrochlorothiazide* (WHO model list of essential medicines).

Examples of common properties Thiazide diuretics are prone to hypokalaemia, metabolic disorders (hyperglycaemia, hyperuricemia with gout attacks), lipid disorders, photosensitization, erectile dysfunction, hypochloremic alkalosis

Inhibitors of renal epithelial Na^+ channels (K^+ sparing diuretics)

Triamterene and *amiloride* are the only two medicines of this class in clinical use.

Antagonists of mineralocorticoid receptor (aldosterone antagonists, K^+ sparing diuretics)

Stem –*renone* is for "aldosterone antagonists, spironolactone derivatives"

All INNs with this stem belong to this pharmacological class except for *teprenone* used for gastric protection, *ubidecarenone* used as antioxidant. This stem was used first time for *canrenone* and *dicirenone*.

These diuretics expose to gynecomastia

Inhibitors of the non specific cation channel: atrial natriuretic peptides

Stem –*ritide* is for "natriuretic factor type substances"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *anaritide*.

Stem –*vaptan* is for "vasopressin receptor antagonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *conivaptan* and *relcovaptan*.

▪ *C04 PERIPHERAL VASODILATORS*

Stem –*dil*, *dilol* is used for "vasodilators"

All INNs with this stem belong to this pharmacological class except for: *diloxanide* (amebicide), *methdilazine* (antihistaminic). For *dilazep* and *diltiazem*, stem is not at the end of INN. This stem was used the first time for *benfurodil hemisuccinate*.

▪ *C05 VASOPROTECTIVES*

Medicines in this group are very heterogeneous with no common stem.

▪ *C07 BETA BLOCKING AGENTS*

Stems –*alol*, -*olol* are used for "Beta adrenoreceptor antagonists"

All INNs with this stem belong to this pharmacological class except for *stanozolol* (anabolic steroid). *Bisoprolol, propranolol, timolol* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties: Beta blockers are competitive antagonists of catecholamines at beta-adrenergic receptors in a wide range of tissues. Although they have broadly similar properties they differ in their affinity for $beta_1$ or $beta_2$ receptor subtypes, intrinsic sympathomimetic activity, membrane-stabilising activity, blockade of alpha-adrenergic receptors, and pharmacokinetic properties including differences in lipid solubility. These differences may affect the choice of drug in specific situations.

C08 CALCIUM CHANNEL BLOCKERS

Stem –*dipine* is used for "calcium channel blockers, nifedipine derivatives"

All INNs with this stem belong to this pharmacological class except for *budipine* (antiparkinsonian). *Nifedipine* (WHO Model List of Essential Medicines) belongs to this class.

Stem –*tiazem* is used for "calcium channels blockers, diltiazem derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *diltiazem*.

Stem –*pamil* calcium channels blockers, verapamil derivatives

All INNs with this stem belong to this pharmacological class. *verapamil* (WHO Model List of Essential Medicines) belongs to this class.

All calcium channel blockers are highly metabolized and sensitive to enzyme inducers

C09 AGENTS ACTING ON THE RENIN-ANGIOTENSIN SYSTEM

Stem –*pril*(*at*) is for "angiotensin-converting enzyme inhibitors"

All INNs with this stem belong to this pharmacological class. *enalapril* (WHO Model List of Essential Medicines) belongs to this class.

Non-peptide angiotensin II receptor antagonists

Stem –*sartan* is for "angiotensin II receptors antagonists, antihypertensives (non-peptidic)"

All INNs with this stem belong to this pharmacological class. *losartan* (WHO Model List of Essential Medicines) belong to this class.

Direct renin inhibitors

Stem –*kiren* is for "renin inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *enalkiren*.

Examples of common properties: All agents acting on the renin-angiotensin system have a common foetal toxicity during 2nd an 3rd trimesters of pregnancy. Cough is a frequent side effect with angiotensin converting enzyme inhibitors. It seems less important with –sartans.

C10 LIPID MODIFYING AGENTS

Drug therapy of dyslipidemia

C10AA HMG CoA reductase inhibitors

Stem –*vastatin* is for "antihyperlipidaemic substances, HMG CoA reductase inhibitors"

All INNs with this stem belong to this pharmacological class. *simvastatin* (WHO Model List of Essential Medicines) belongs to this class.

Examples of common properties: The commonest adverse effects of therapy with statins are gastrointestinal disturbances. Dose-related myopathy, characterised by myalgia and muscle weakness and associated with increased creatine phosphokinase concentrations, has been frequently reported. Drug interactions may increase the risk of myopathy. Rarely, rhabdomyolysis with acute renal failure may develop. Also, rarely, an immune-mediated necrotising myopathy has been reported during or after treatment with some statins.

▪ *C01AB Fibric acid derivatives: PPAR activators*

Stem *–fibrate* is used for "clofibrate derivatives, peroxisome proliferator activated receptor α (PPARα) agonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *simfibrate*.

Example of common properties: Some fibrates enhance the effects of *warfarin*. All fibrates increase the risk of biliary lithiasis.

▪ *C01AC Bile-acid sequestrants*

The two established bile-acid sequestrants or resins (*cholestyramine* and *colestipol*) are among the oldest of hypolipidemic drugs.

▪ *C01AD Niacin (nicotinic acid)*

Stem *nico-* or *nic-* or *ni-*is used for "nicotinic acid or nicotinoyl alcohol derivatives" but it is not useful because many drugs with various MOA contain this stem

▪ *C01AX Other lipid modifying agents*

Ezetimibe and the inhibition of dietary cholesterol uptake

Stem *–imib* is used for "antihyperlipidaemics, acylCoA: cholesterol acetyl transferase (ACAT) inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *octimibate*.

Stem *–tapide* is for "microsomal triglyceride transfer protein (MTP) inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *implitapide*.

Stem *–cetrapid* is for "cholesteryl ester transfer protein (CETP) inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *torcetrapid*.

DERMATOLOGICALS

Most of drugs included in chapter "dermatologicals" are also treated in other chapters.

▪ *D05 ANTIPSORIATICS*

Stem –*arotene* is for "arotinoid derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *betacarotene*.

Stem –*retin* is for "retinol derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *tretinoin*.

Examples of common properties: Animal studies have indicated that aratinoid derivatives and retinol derivatives are fetotoxic and teratogenic. Licensed product information recommend that these drugs should not be used during pregnancy or in women planning a pregnancy; they also advise starting therapy during normal menstruation, within 2 weeks of confirming a negative pregnancy test in women of child-bearing potential. Similarly, these drugs should not be used, or used with caution, during breast feeding, as animal data indicate that they may be distributed into breast milk.

GENITO URINARY SYSTEM AND SEX HORMONES

- ***G01 GYNECOLOGICAL ANTIINFECTIVES AND ANTISEPTICS***

  Drugs treated in other chapters.

- ***G02 OTHER GYNECOLOGICALS***

- ***G02AB Ergot alcaloids***

  Stem –*erg* is used for "Ergot derivatives" ; -golide is used for "Dopamine receptor agonists, ergoline derivatives"

  All INNs with this stem belong to this pharmacological class. r*otigotine* also belong to this class. *ergocalciferol* does not belong to this class. *Ergometrine* WHO model list of essential medicines) belongs to this class.

  Examples of common properties: Ergot derivatives cause retroperitoneal fibrosis, pleuropulmonary fibrosis and cardiac valvulopathies. They cause vasoconstrictions with, among other things, aggravation of Raynaud's phenomena. They also cause compulsive disorders (pathological gambling, hypersexuality,...).

- ***G02AD Prostaglandins***

  Stem –*prost*- is used for "prostaglandins"

  All INNs with this stem belong to this pharmacological class. *misoprostol* (WHO model list of essential medicines) belongs to this stem.

  Examples of common properties The pharmacological properties of prostaglandins are wide-ranging and include contraction or relaxation of smooth muscle in the blood vessels, bronchi, uterus, and gastrointestinal tract; inhibition of gastric acid secretion; and effects on platelet aggregation, the endocrine system, and metabolic processes. The diverse clinical applications of prostaglandins reflect their wide-ranging physiological and pharmacological properties.

- ***G02CX Other gynecologicals***

  Stem –*siban* is used for "oxytocin antagonists

  All INNs with this stem belong to this pharmacological class. This stem was used the first time for *atosiban*.

- ***G03 SEX HORMONES AND MODULATORS OF THE GENITAL SYSTEM***

- ***G03A Hormonal contraceptives for systemic use***

  Estrogens have stem estr and progestogens stem gest. *levonorgestrel* belongs to the WHO Model List of Essential Medicines.

G03B Androgens

Stem *–ster-* is used for androgen/ anabolic steroids" but also for "progestational steroids". This lack of specificity makes this stem not useful, even confusing, for teaching pharmacology

G03D Progestogens

Stem *gest* is for "steroids, progestogens"

About 1/3 of INNs of progestogens do not contain this stem.

Stem *–pris-* is used for "steroidal compounds acting on progesterone receptors (excluding *–gest-* compounds)"

All INNs with this stem belong to this pharmaceutical class. *mifepristone* (WHO Model List of Essential Medicines) belongs to this class.

Warning: Stem *–pristin* is selected for antibacterials.

G04 UROLOGICALS

G04BD Drugs for urinary frequency and incontinence

Stem *–begron* is used for "beta$_3$ adrenoreceptor agonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *talibegron.*

Stem *–fenacin* is used for "muscarinic receptor antagonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *tofenacin.*

G04BE Drugs used in erectile dysfunction

Stem *–afil* is used for "inhibitors of phosphodiesterase PDE5 with vasodilator action"

All INN with this stem belong to this pharmacological class. This stem was used the first time for *vardenafil.*

G04CB Testosterone-5-alpha reductase inhibitors

Stem *–steride* is used for "testosterone reductase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *finasteride.*

SYSTEMIC HORMONAL PREPARATIONS, EXCL. SEX HORMONES AND INSULINS

▪ *H01 PITUITARY AND HYPOTHALAMIC HORMONES AND ANALOGUES*

Stem *–relin* is for "pituitary hormone-release stimulating peptides"

All INNs with this stem belong to this pharmacological class. *leuprorelin* (WHO Model List of Essential Medicines) belongs to this class.

Stem *–actide* is for "synthetic polypeptides with a corticotropin-like action"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *tetracosactide*.

Stem *–morelin* is for "growth hormone release-stimulating peptides"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *sermorelin*.

Stem *–tirelin* is for "thyrotropin releasing analogues

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *protirelin*.

Natural and recombinant gonadotropins

-tropin is not a stem. They would have a risk of confusion with Stem *–trop-* (atropine derivatives)

Stem *–pressin* is for "vasoconstrictors, vasopressin derivatives"

All INNs with this stem belong to this pharmacological class. *desmopressin* (WHO Model List of Essential Medicines) belongs to this class.

Stem *–relix* is for "gonadotropin-releasing hormone (GnRH) inhibitors, peptides

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *detirelix*.

▪ *H02 CORTICOSTEROIDS FOR SYSTEMIC USE*

Stem *cort* corticosteroids, except prednisolone derivatives

All INNs with this stem belong to this pharmacological class but 4 of them are prednisolone derivatives (*clocortolone, difluocortolone, fluocortolone, halocortolone*). This stem was used the first time for *cortisone*.

Stem *pred* is used for "prednisone and prednisolone derivatives"

All INNs with this stem belong to this pharmacological class but Stem *–metasone* or *–methasone* is also used and Stem *–olone* is used for steroids not used as glucocorticosteroids. *Prednisolone* belongs to WHO model list of essential medicines.

Stem –*onide* is used for "steroids for topical use, acetal derivatives"

All INNs with this stem belong to this pharmacological class but *amcinafal* is also a steroid for topical use. *budesonide (*WHO Model List of Essential Medicines*) belongs to this class.*

Examples of common properties: The corticosteroids are traditionally divided into those with mainly glucocorticoid actions, of which cortisol (hydrocortisone) is the most important endogenous example, and those that are mainly mineralocorticoid, of which aldosterone is much the most important.

The main mineralocorticoid actions are on fluid and electrolyte balance. They enhance sodium reabsorption in the kidney and hence expand the extracellular fluid volume, and they enhance renal excretion of potassium and H^+.

The glucocorticoid actions are wide-ranging. They have potent anti-inflammatory and immunosuppressive effects, at least partly through inhibition of the release of various cytokines, and it is mainly these that are made use of clinically. They also have profound metabolic effects.

Corticosteroids are usually contra-indicated in the presence of acute infections uncontrolled by appropriate antimicrobial therapy. Similarly, patients already receiving corticosteroids are more susceptible to infection, the symptoms of which, moreover, may be masked until an advanced stage has been reached. During prolonged courses of corticosteroid therapy, patients sodium intake may need to be reduced and calcium and potassium supplements may be necessary.

The risk of systemic absorption should always be considered when applying corticosteroids topically.

Inhibitors of the biosynthesis and action of adrenocortical steroid

Medicines in this class are very heterogeneous with no common stem.

▪ *H03 THYROID THERAPY*

No common stem

Anti-thyroid drugs and others thyroid inhibitors

No common stem

▪ *H04 PANCREATIC HORMONES*

No common stem

▪ *H05 CALCIUM HOMEOSTASIS*

No common stem

ANTIINFECTIVES FOR SYSTEMIC USE

J01 ANTIBACTERIALS FOR SYSTEMIC USE

J01A Tetracyclines

Tetracyclines and glycylcyclines

Stem –*cycline* is used for "antibiotics, protein-synthesis inhibitors, tetracycline derivatives"

All INNs with this stem belong to this pharmacological class. *doxycycline, tetracycline,tigecycline* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties: Tetracyclines all have a broad spectrum of activity but the emergence of resistant strains and the development of other antimicrobials has often reduced their value. Adverse effects have also restricted their usefulness. Gastrointestinal disturbances are common and other important toxic effects include deposition in bones and teeth, precluding their use in pregnancy and young children. Because of these adverse effects tetracyclines should be avoided in pregnant women, children.

J01B Amphenicols

phenicol is not a stem. *Chloramphenicol* (WHO Model List of Essential Medicines) belongs to this class.

J01C Beta-lactam antibacterials, penicillins

The penicillins

Stem –*cillin* is used for "antibiotics, 6-aminopenicillanic acid derivatives"

All INNs with this stem belong to this pharmacological class. *benzylpenicillin,cloxacillin* (WHO Model List of Essential Medicines) belong to this class.

Example of common properties: Hypersensitivity reactions are by far the most common adverse effects noted with the penicillins, and these agents are amongst the most common causes of drug allergy.

The aminopenicillins

Stem –*cillin* antibiotics, 6-aminopenicillanic acid derivatives

amoxicillin, ampicillin (WHO Model List of Essential Medicines) belongs to this class.

Anti-pseudomonal penicillins

Stem –*cillin* antibiotics, 6-aminopenicillanic acid derivatives

piperacillin(WHO Model List of Essential Medicines) belongs to this class.

▪ *J01D* Other beta-lactam antibiotics

The cephalosporins

Stem *cef-* is used for "antibiotics, cefalosporanic acid derivatives"

All INNs with this stem belong to this pharmacological class. *cephalexin, cefazolin, cefepime, cefixime, cefotaxime, ceftaroline, ceftazidime, ceftriaxone* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties The most widely used system of classification of cephalosporins is by generations and is based on the general features of their antibacterial activity, but may depend to some extent on when they were introduced. Succeeding generations generally have increasing activity against Gram-negative bacteria.

cefalotin was one of the first cephalosporins to become available and is representative of the first-generation cephalosporins. *cefamandole* was the first available second-generation cephalosporin. It has similar or slightly less activity than *cefalotin* against Gram-positive bacteria, but greater stability to hydrolysis by beta lactamases produced by Gram-negative bacteria and enhanced activity against many of the Enterobacteriaceae and *Haemophilus influenzae*. The third-generation cephalosporins, sometimes referred to as extended-spectrum cephalosporins, are even more stable to hydrolysis by beta lactamases than *cefamandole* and *cefuroxime*. Compared with the earlier generations of cephalosporins they have a wider spectrum and greater potency of activity against Gram-negative organisms, including most clinically important Enterobacteriaceae. The newer cephalosporins *cefepime* and *cefpirome* are generally considered to be fourth-generation because of their broad spectrum of activity. *ceftobiprole* and *ceftaroline* are active against meticillin-resistant staphylococci, and are therefore sometimes termed fifth-generation cephalosporins.

Other beta lactam antibiotics

Carbapenems

Stem *penem* is used for "analogues of penicillanic acid antibiotics modified in the five-membered ring"

All INNs with this stem belong to this pharmacological class. This stem was use the first time for *imipenem*.

Beta lactamase inhibitors

Stem *–bactam* is used for "beta-lactamase inhibitors"

All INNs with this stem belong to this pharmacological class except for the most known of them: *clavulanic acid*. This stem was used the first time for *sulbactam*.

▪ *J01E* Sulfonamides and trimethoprim

Stem *sulfa-* isused for "anti-infectives, sulphonamides

Many antibiotics belong to this class but without this stem.

Warning: *galsulfase* and *idursulfase* are enzymes and not antibiotics.

Stem –*prim* is used for "antibacterials, dihydrofolate reductase (DHFR) inhibitors, trimethoprim derivatives.

All INNs with this stem belong to this pharmacological class. *trimethoprim* (WHO Model List of Essential Medicines) belong to this class.

▪ *J01F Macrolides, lincosamides and streptogramins.*

Macrolides and ketolides

Stem –*mycin* is used for "Antibiotics, produced by Streptomyces strains" but it is not specific

azithromycin (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties Except for *spiramycin*, macrolides have many risks of pharmacokinetic interactions.

Lincosamides

Stem –*mycin* (not specific) *clindamycin* **(WHO Model List of Essential Medicines) belong to this class.**

Steptogramins

Stem –*pristin* is used for "antibacterials, streptogramins, protein synthesis inhibitors, pristinamycin derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used first time for *quinupristin*.

▪ *J01G Aminoglycoside antibacterials*

Stem –*mycin* is used for "antibiotics, produced by Streptomyces strains" but it is not specific because it is also used for other antibiotics and antineoplastics.

Examples of common properties The aminoglycosides have broadly similar toxicological features. Ototoxicity is a major limitation to their use. Aminoglycosides should in general only be used for the treatment of serious infections because of their potential toxicity and antimicrobial spectrum.

spectinomycin (WHO Model List of Essential Medicines) belongs to this class.

Stem –*kacin* is used for "antibiotics, kanamycin and bekanamycin derivatives"

Warning: *dihydrostreptomycin, streptomycin, apramycin, kanamycin, nebramycin, tobramycin* belong to this pharmacological class but without this stem. *amikacin* (WHO Model List of Essential Medicines) belongs to this class.

Example of common properties: All aminoglycosides have the potential to produce reversible and irreversible ototoxicity, renal toxicity and neuromuscular blockade.

▪ *J01M* Quinolone antibacterials

Stem –*oxacin* is used for"antibacterials, nalidixic acid derivatives"

All INNs with this stem belong to this pharmacological class. *flumequine, nalidixic acid, oxolinic acid, pipemidic acid, piromidic acid, metioxate* also belong to this class. *Ciprofloxacin, levofloxacin, moxifloxacin, ofloxacin* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties: Fluoroquinolones can cause sometimes severe neuropsychic disorders, prolongation of the QT interval, and joint damage in growing animals. They are to be avoided in pregnant women and children.

▪ *J01X* Other antibacterials

Oxazolidinones

Stem –*zolid* is used for "oxazolidinone antibacterials"

All INNs with this stem belong to this pharmacological class. This stem was use the first time for

linezolid (WHO Model List of Essential Medicines).

Aminocyclitols

Stem –*mycin* (not specific)

Polymyxins

Substances in this class do not have common stem.

colistin (WHO Model List of Essential Medicines) belongs to this class.

Glycopeptides

Stem –*planin* is used for "glycopeptide antibacterials (Actinoplanes strains)"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *actaplanin.*

Lipopeptides

INNs in this class have no common stem**.**

▪ *J02* ANTIMYCOTICS FOR SYSTEMIC USE

Stem –*conazole* is used for "systemic antifungal agents, miconazole derivatives"

All INNs with this stem belong to this pharmacological class. *Bifonazole* and *isavuconazonium chloride*. *fluconazole, itraconazole, voriconazole* (WHO Model List of Essential Medicines) also belong to this class without the stem in their INN.

Example of common properties: All miconazole derivatives are substrates and inhibitors of isoenzymes CYPs. They have many interactions with other drugs.

Stem –*fungin* antifungal antibiotics

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *fusafungine.*

J04 ANTIMYCOBACTERIALS

Many antimycobacterials included in WHO model list of essential medicines have no common stem: *bedaquilline, clofazimine, cycloserine, ethionamide, ethambutol, isoniazid, pyrazinamide.*

Rifamycins

Stem *rifa-* is used for "antibiotics, rifamycin derivatives"

All INNs with this stem belong to this pharmacological class. *rifabutin, rifampicine, rifapentine* (WHO Model List of Essential Medicines) belong to this class.

Aminoglycosides

INNs in this class have no common stem.

Dapsone

Stem *–dapsone* is used for "antimycobacterials, diamino diphenylsulfone derivatives

All INNs with this stem belong to this pharmacological class. *dapsone* (WHO Model List of Essential Medicines) belongs to this class.

J05 ANTIVIRALS FOR SYSTEMIC USE

Anti-herpes virus agents

No specific stem. *aciclovir* (WHO Model List of Essential Medicines) belongs to this class.

Anti-influenza agents

Stem *–mantadine* adamantine derivatives

This stem is not specific for antiviral agents.

Antihepatitis agents

Stem *–previr* is used for Hepatitis Virus (VHC) protease inhibitors

All INNs with this stem belong to this pharmacological class. *simeprevir* (WHO Model List of Essential Medicines) belong to this class.

Other antiviral agents

No specific stem.

Nucleoside and nucleotide inverse transcriptase inhibitors

No specific stems

Stems *vir, vudine* and *citabine* are not specific for antiretroviral agents. *zidovudine* (WHO Model List of Essential Medicines) belongs to this class.

Non nucleotide inverse transcriptase inhibitors

Stem *–virine* is used for "non nucleotide reverse transcriptase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *emivirine, rilpivirine.*

HIV protease inhibitors

Stem –*navir* is used for "HIV protease inhibitors"

All INNs with this stem belong to this pharmacological class. *atazanavir, darunavir,lopinavir, ritonavir* (WHO Model List of Essential Medicines) belong to this class.

Entry inhibitors

Stem –*viroc* is used for CCR5 (Chemokine CC motif receptor 5) receptor antagonists

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *ancriviroc.*

Integrase inhibitors

No stem (-*tegravir* for "HIV integrase inhibitors) is a prestem. *raltegravir* (WHO Model List of Essential Medicines) belongs to this class.

- ***J06* IMMUNE SERA AND IMMUNOGLOBULINS**

- ***J07* VACCINES**

  Only a few vaccines have a INN without a common stem.

ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS

- ***L01 ANTINEOPLASTIC AGENTS***

- ***L01A Alkylating agents and platinum coordination complexes***

- ***L01AA Nitrogen mustards***

Stem –*fosfamide* is used for "alkylating agents of the cyclophosphamide group"

All INNs with this stem belong to this pharmacological class. *cyclophosphamide, ifosfamide* (WHO Model List of Essential Medicines) belong to this class.

- ***L01AB Alkyl sulfonates***

Stem –*sulfan* is used for "antineoplastics, alkylating agents, methanesulfonates"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *busulfan*.

- ***L01AC Ethyleneimines***

Stem –*tepa* is used for "antineoplastics, thiotepa derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *thiotepa*.

- ***L01AD Nitrosoureas***

Stem –*mustine* is used for "antineoplastic, alkylating agents, (beta-chloroethyl)amine derivatives"

All INNs with this stem belong to this pharmacological class but they are a lot of INNs corresponding to this pharmacological class but without this stem. *bendamustine* (WHO Model List of Essential Medicines) belongs to this class.

- ***L01AX Other alkylating agents***

Triazenes
No stem

Platinum coordination complex

Stem –*platin* is for "antineoplastic agents, platinum derivatives"

All INNs with this stem belong to this pharmacological class. *carboplatin, cisplatin, oxaliplatin* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties Platinum salts are nephrotoxics and produce severe nauseas and vomitings.

▪ *L01B ANTIMETABOLITES*

▪ *L01BA Folic acid analogues*

Stem *–trexate* is used for "folic acid analogues"

All INNs with this stem belong to this pharmacological class. *methotrexate* (WHO Model List of Essential Medicines) belongs to this class.

Stem *–trexed* is used for antineoplastics, thymidylate synthetase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *pemetrexed* and *nolatrexed.*

▪ *L01BB Purine analogs*

Stem *–(a)rabine* is used for "arabinofuranosyl derivatives"

All INNs with this stem belong to this pharmacological class. *ribavirin* and *taribavirin* also belong to this class. *cytarabine, fludarabine* (WHO Model List of Essential Medicines) belong to this stem.

▪ *L01BC Pyrimidine analogs*

Not specific stems

***–ur –uridine* uridine derivatives used as antiviral agents and as antineoplastics**

fluorouracil (WHO Model List of Essential Medicines) belongs to this class.

This stem is not specific: antiviral or antineoplastic agents.

Cytidine analogs

Not specific Stem *–citabine* nucleosides antiviral or antineoplastic agents, cytarabine or azacitidine derivatives. *capecitabine* (WHO Model List of Essential Medicines) belongs to this class.

▪ *L01C PLANT ALKALOIDS AND OTHER NATURAL PRODUCTS*

▪ *L01CA Vinca alkaloids*

Stem *vin-* is used for "vinca alkaloids" but is not useful because it is used for antineoplastics, "stimulators" of cerebrovascular circulation. *vinblastine, vincristine, vinorelbine* (WHO Model List of Essential Medicines) belong to this class.

▪ *L01CB Podophyllotoxin derivatives*

No common stem. *etoposide* (WHO Model List of Essential Medicines) belongs to this class.

▪ *L01CD Taxanes*

Stem *–taxel* is used for "antineoplastics; taxane derivatives"

All INNs with this stem belong to this pharmacological class. *docetaxel, paclitaxel* (WHO Model List of Essential Medicines) belong to this class.

Comment: Taxanes commonly cause peripheral neuropathy.

▪ *L01CX Other plant alkaloids and natural products*

Epothilones

No stem

Camptothecin analogs

Stem –*tecan* is used for "antineoplastics; topoisomerase I inhibitors"

All INNs with this stem belong to this pharmacological class. *irinotecan* (WHO Model List of Essential Medicines) belongs to this class.

Example of common properties: Dose limiting toxicities are neutropenia and diarrhea.

▪ *L01D CYTOTOXIC ANTIBIOTICS AND RELATED SUBSTANCES*

▪ *L01DB Anthracyclines and related substances*

Stem –*rubicin* antineoplastics, daunorubicin derivatives

All INNs with this stem belong to this pharmacological class. *daunorubicin*, *doxorubicin* (WHO Model List of Essential Medicines) belong to this list.

Examples of common properties: *daunorubicin* and other anthracyclines cause pronounced bone-marrow depression, which may be dose-limiting.

The anthracyclines produce cardiotoxicity, both as an acute, usually transient disturbance of cardiac function and as a delayed, sometimes fatal, irreversible congestive heart failure, which may occur suddenly. Severe cardiotoxicity is linked to total cumulative doses.

Anthracenediones

Stem –*antrone* is used for "antineoplastics, anthraquinone derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *mitoxantrone*.

▪ *L01X Other antineoplastic agents*

Stem –*bulin* is for "antineoplastics, mitotic inhibitors, tubulin binders"

thyroglobulin does not belong to this class. This stem was used the first time for *mivobulin*.

Examples of common properties: tubulin binders commonly cause peripheral neuropathy

Stem *mito-* is for "antineoplastics, nucleotoxic agents"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *mitogillin, mitopodozide, mitotenamine*.

Stem –*parib* is for "poly-ADP-ribose polymerase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *olaparib*.

Stem –*tansine* is for "maytansinoid derivatives, antineoplastics"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *maitansine*.

Stem –*degib* is used for "SMO receptor antagonists"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *vismodegib*.

- ***L01XE* Protein tyrosine kinase inhibitors**

Stem –*tinib* is used for "tyrosine kinase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *arlotinib, gefitinib*.

Stem –*rafenib* is for "Raf (rapidely accelerated fibrosarcoma) kinase inhibitors

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *sorafenib*.

Enzymes

No useful stem. The Stem –*ase* is reserved to all enzymes and hence does not provide any indication of the activity.

Differentiating agents

No stem or not useful stem

Targeted therapies: tyrosine kinase inhibitors, monoclonal antibodies and cytokines

Epidermal growth factor receptor inhibitors

Stem –*tinib* is used we do not have a specific substem for EGFR inhibitors

Inhibitors of angiogenesis

Stem –*anib* is for angiogenesis inhibitors

All INNs with this stem belong to this pharmacological class but some inhibitors of angiogenesis have Stem –*tinib*. This stem was used the first time *for vatalanib*.

Examples of common properties: Angiogenesis inhibitors have a common profile of side effects.

Stem –*sertib* is for "serine/threonine kinase inhibitors

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *danusertib*.

Proteasome inhibition

Stem –*zomib* is used for "proteasome inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *bortezomib*.

mTor inhibitors: rapamycin analogs

Stem –*rolimus* is used for "immunosuppressants, rapamycin derivatives" but it is not specific

Biological response modifiers

Stem –*leukin* is used for "interleukin-2 analogues and derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *aldesleukin*.

- ***L02 ENDOCRINE THERAPY***

- ***L02A Hormones and related agents***

- ***L02AA Estrogens and androgens***

  See chapters G

- ***L02AB Progestogens***

  See chapter G

- ***L02B HORMONE ANTAGONISTS AND RELATED AGENTS***

- ***L02BA Anti-estrogens***

  Stem –*ifene* is for "antiestrogens or estrogen receptor modulators, clomifene and tamoxifen derivatives"

  All INNs with this stem belong to this pharmacological class. *clomifene* (WHO Model List of Essential Medicines) belongs to this class.

- ***L02 BB Anti-androgens***

  Stem –*lutamide* non-steroid antiandrogens

  aceglutamide does not belong to this pharmacological class. *bicalutamide* (WHO Model List of Essential Medicines) belongs to this class.

- ***L02BG Aromatase inhibitors***

  Stem –*mestane* is used for "aromatase inhibitors"

  All INNs with this stem belong to this pharmacological class. This stem was used the first time for *atamestane*.

Stem –*rozole* is used for "aromatase inhibitors, imidazole-triazole derivatives"

aminotrozole, sulfatrozole, tenonitrozole do not belong to this pharmacological class. This stem was used the first time for *fadrozole, liarozole* and *vorozole*.

Hormone therapy in prostate cancer

Gonadotropin-releasing hormone agonists and antagonists

Stem –*relin* pituitary hormone-release stimulating peptides

See chapter G

▪ *L03 IMMUNOSTIMULANTS*

▪ *L03A Immunostimulants*

▪ *L03AA Colony stimulating factors*

Stems –*stim* colony stimulating factors

-*gramostim* granulocyte macrophage stimulating factor (GM-CSF) type substances

-*grastim* granulocyte colony stimulating factor (G-CSF) type substances

All INNs with this stem belong to this pharmacological class. *filgrastim* (WHO Model List of Essential Medicines) belongs to this class.

Thrombopoietic growth factors

Stem –*stim* for "colony stimulating factors" is not specific

▪ *L04 IMMUNOSUPPRESSANTS*

▪ *L04AA Selective immunosuppressants*

Stem –*imod* (-mapimod) is for immunomodulators, both stimulant/suppressive and stimulant

All INNs with this stem belong to this pharmacological class. This stem was used the first time for tiprotimod.

▪ *L04AD Calcineurin inhibitors*

No useful stem.

Antiproliferative and antimetabolic drugs

Stem –*imus* is for "immunosuppressants (other than antineoplastics)"

All INNs with this stem belong to this pharmacological class.

Monoclonal antibodies

Stem –*mab* is for "monoclonal antibodies".

This stem is not specific for antineoplastics.

MUSCULO-SKELETAL SYSTEM

M01 ANTIINFLAMMATORY AND ANTIRHEUMATIC PRODUCTS

Comments: It is considered that there are only small differences in anti-inflammatory activity between the various NSAIDs and choice is largely empirical. Responses of individual patients vary widely. The commonest adverse effects of NSAIDs are generally gastrointestinal disturbances, such as gastrointestinal discomfort, nausea, and diarrhoea; these are usually mild and reversible but in some patients peptic ulceration and severe gastrointestinal bleeding may occur.

NSAIDs use have to be avoided during all pregnancy.

Stem –*ac* is for "anti-inflammatory agents, ibufenac derivatives"

bufexamac is an anti-inflammatory agent acetohydroxamic acid group instead of acetic acid group.

amtometin guacil, clamidoxic acid, fenclozic acid, metiazinic acid, prodolic acid, tolmetin belong to this group without the Stem –*ac*.

This stem was used the first time for *diclofenac.*

Stem –*fenamic* acid is for "anti-inflammatory anthranilic acid derivatives"

All INNs with this stem belong to this pharmacological group. This stem was used the first time for *clofenamic acid, flufenamic acid, mefenamic acid.*

Stem –*fenamate* is for "fenamic acid derivatives"

All INNs with this stem belong to this pharmacological group. This stem was used the first time for *colfenamate, etofenamate.*

Stem –*coxib* is for "selective cyclo-oxygenase inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *celecoxib, deracoxib, parecoxib, rofecoxib, valdecoxib.*

Examples of common properties Selective COX-2 inhibitors are associated with a lower incidence of serious gastrointestinal effects, such as bleeding, perforation, and obstruction, than the traditional NSAIDs but they can induce severe cardiovascular effects.

Stem –*icam* is for "anti-inflammatory, isoxicam derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *isoxicam.*

Stem –*metacin* is for "anti-inflammatory, indomethacin derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *indometacin.*

Stem –*profen* is for "anti-inflammatory agents, ibuprofen derivatives"

All INNs with this stem belong to this class; *tiaprofenic acid* also. *ibuprofen* (WHO model list of essential medicines) belongs to this class.

▪ *M02* TOPICAL PRODUCTS FOR JOINT AND MUSCULAR PAIN

▪ *M03* MUSCLE RELAXANTS

Neuromuscular blocking agents

No stem is useful

Stem *–ium* is used for "Quaternary ammonium compounds" but INNs including Stem *–ium* can be used for neuromuscular blocking agents, cholinergic agents, anticholinergic agents, surfactants used as antibacterial and antiseptics, other agents.

▪ *M04* ANTIGOUT PREPARATIONS

INNs in this class are heterogeneous without common stem. *allopurinol* (WHO Model List of Essential Medicines) belongs to this class.

▪ *M05* DRUGS FOR TREATMENT OF BONE DISEASES

Biphosphonates

Stem *–dronic* acid is used for "calcium metabolism regulator, pharmaceutical aid"

All INNs with this stem belong to this pharmacological class. *zoledronic acid* (WHO Model List of Essential Medicines) belongs to this class.

Examples of common properties: Bisphosphonates may cause peptic ulcerations. Existing gastrointestinal problems may be exacerbated, and oral bisphosphonates should generally be given with care.

Osteonecrosis of the jaw has been reported in patients given bisphosphonates

Calcium sensor mimetics: cinacalcet

INNs in this class are heterogeneous without common stem.

Treatment of osteoporosis

Stem *–ifene* is used for "antiestrogens or estrogen receptor modulators, clomifene and tamoxifen derivatives"

All INNs with this stem belong to this pharmacological class. *clomifene* (WHO Model List of Essential Medicines) belongs to this class.

NERVOUS SYSTEM

- ***N01 ANESTHETICS***

- ***N01A Anesthetics, general***

Parenteral anesthetics

No common stem

Absence of stem is not a problem. It is a marginal very specialized chapter of pharmacology

Inhalational anesthetics

Stem –*flurane* is for "halogenated compounds used as general inhalation anaesthetics"

apaflurane does not belong to this class. *fluroxene and halothane* belong to this class without the stem. *isoflurane* (WHO Model List of Essential Medicines) belongs to this class.

- ***N01B Anesthetics, local***

Stem –*caine* is for "local anesthetics "

All INNs with this stem belong to this pharmacological class. *dyclonine* belongs to this class without the stem. *bupivacaine, lidocaine, tetracaine* (WHO Model List of Essential Medicines) belong to this class.

- ***N02 ANALGESICS***

- ***N02A Opioids***

Morphine and structurally related agonists

Stem *orphan*, *-orph-*, *-orphinol*, *-orphone* is for "opioid receptor antagonists/agonists, morphinan derivatives"

emorfazone is an anti-inflammatory drug. *orphenadrine* is an antiparkinsonian. *morphine* is included in WHO model list of essential medicines.

Benzomorphan derivatives

Stem –*azocine* is for "narcotic antagonists/agonists related to 6,7-benzomorphan"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *phenazocine.*

Stem –*adol* analgesics

alfadolone is a general anesthetic, *nadolol* is a beta blocker, *quinestradol* is an estrogenic. This stem was used the first time for *acetylmethadol, alphacetylmethadol, alphamethadol,betacetylmethadol, betamethadol.*

Meperidine, diphenoxylate, loperamide

No common stem. *loperamide* is included in WHO Model List of Essential Medicines.

Piperidine and phenylpiperidine analgesics

Stem –*fentanil* is for "opioid receptor agonists, analgesics, fentanyl derivatives"

All INNs with this stem belong to this pharmacological class. *fentanyl* is included in WHO Model List of Essential Medicines.

Opioids agonists/antagonists and partial agonists

Stem *nal*- is for "opioid receptor antagonists/agonists related to normorphine"

nalidixic acid is an antibacterial. *naloxone* (WHO Model List of Essential Medicines) belongs to this class.

▪ *N02B Other analgesics and antipyretics*

▪ *N02C Antimigraine preparations*

Stem –*triptan* is used for serotonin($5HT_1$) receptor agonists, sumatriptan derivatives »

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *oxitriptan*.

Examples of common properties: Overuse of drugs triptans, and analgesics to treat headache or migraine can lead to dependence and paradoxical chronic daily headache. Triptans should not be used for prophylaxis but only for treatment of acute episodes.

▪ *N03 ANTIEPILEPTICS*

Examples of common properties: The two mains problems with antiepileptics are potential of pharmacokinetic interactions and neuropsychics side effects.

Hydantoins

Stem –*toin* is for "antiepileptics, hydantoin derivatives"

nitrofurantoin is an antibacterial. *phenytoin* (WHO Model List of Essential Medicines) belongs to this class.

Comments : Gingival hypertrophy is a classic side effect of hydantoins.

Anti-seizure barbiturates

Stem *barb* is for "hypnotics, barbituric acid derivatives" and this stem is not useful for identifying barbiturates used as antiepileptics.

Iminostilbenes

Stem –*zepine* is for "tricyclic anticonvulsivants"

Stem –*zepine* is not specific: it is used also for antiulcers and antidepressants/ neuroleptics. So it is not useful for learning. *carbamazepine* (WHO Model List of Essential Medicines) belongs to this class.

Succinimides

No stem. *ethosuximide* (WHO Model List of Essential Medicines) belongs to this class.

Other antiseizure drugs

This chapter contains various antiepileptics not related each others and there is no useful stem for identifying these drugs as antiepileptics. *lamotrigine, valproic acid,* belong to this class

Stem –*ampanel* is used for "antagonists of the ionotropic non –NMDA (N-methyl-D-AMPA(-hydroxy-aspartate) glutamate receptor (namely the AMPA 'amino-hyfroxy-methyl-isoxazole propionic acid) and/or KA (kainate antagonists receptors)"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *talampanel.*

▪ *N04 ANTI-PARKINSON DRUGS*

Dopamine receptor agonists

Stem –*golide* is used for "dopamine receptors agonists, ergoline derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *pergolide.*

Examples of common properties: Fibrotic reactions such as cardiac valvulopathy and pleuropulmonary effusion have been reported with ergot derivatives.

Stem –*dopa* is for "dopamine receptor agonists, dopamine derivatives, used as antiparkinsonism/ prolactin inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *methyldopa.*

Catechol-O-metyhyltransferase (COMT) inhibitors

Stem –*capone* is for "catechol-O-methyltransferase (COMT) inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *nitecapone.*

Selective MAO-B inhibitors

Stem –*giline* is for "monoamine oxidase (MAO)-inhibitors type B"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *clorgiline.*

Muscarinic receptor antagonists

Stem –*mantadine* is for "adamantine derivatives". This stem is not useful because it is used for antivirals, antiparkinsonians and immunostimulants.

▪ *N05 PSYCHOLEPTICS*

▪ *N05A Antipsychotics*

Stem –*peridol* is for "antipsychotics, haloperidol derivatives"

All INNs with this stem belong to this pharmacological class. *haloperidol* (WHO Model List of Essential Medicines) belongs to this class.

Example of common properties: *haloperidol* derivatives do not induce atropinic side effects.

Stem –*peridone* is for "antipsychotics, risperidone derivatives"

All INNs with this stem belong to this pharmacological class. *risperidone* (WHO Model List of Essential Medicines) belongs to this class.

Stem –*apine* is for "psychoactive"

Stem –*apine* cannot be used for teaching neuroleptics because it is a very heterogeneous group with also antidepressants for example

Concluding remarks: stems have a limited value for teaching neuroleptics: they are not correlated with MOA, many drugs have no stem. Structure-activity relationship is only useful for "classical"neuroleptics.

▪ *N05B Anxiolytics*

Benzodiazepines

Stem –*azepam* is for "diazepam derivative"

All INNs with this stem belong to this pharmacological class but also about twelve INNs for benzodiazepine derivates do not have this stem. *diazepam, lorazepam* (WHO Model List of Essential Medicines) belong to this class.

Examples of common properties: Benzodiazepines were widely used until 1980 years when tolerance and dependence, amnesia/automatism phenomena were described

▪ *N05C Hypnotics and sedatives*

Stem –*clone* is used for "hypnotic tranquillizers"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *barbexaclone*.

Stem –*pidem* is used for hypnotics/sedatives, zolpidem derivatives"

All INNs with this stem belong to this pharmacological class. This stem was used he first time for *alpidem, zolpidem*.

Stem –*plon* is used for "imidazopyrimidine or pyrazolopyrimidine derivatives, used as anxiolytics, sedatives, hypnotics"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *divaplon, fasiplon, taniplon*.

Barbiturates

Stem *barb* is for "hypnotics, barbituric acid derivatives"

This stem is not specific but only old drugs are concerned.

▪ *N06 PSYCHOANALEPTICS*

▪ *N06A Antidepressants*

Monoamine oxidase inhibitors

Stem –*giline* is for "Monoamine oxidase (MAO)-inhibitors type B"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *clorgiline*.

Tricyclic antidepressant and selective reuptake inhibitors

Examples of common properties: Tricyclic antidepressants produce the classic atropinic syndrome.

Stem –*pramine* is used for "substances of the imipramine group"

All INNs with this stem belong to this pharmacological class. *carbamazepine* and *opipramol* also belong to this class. *clomipramine* (WHO model list of essential medicines) belongs to this class.

Example of common properties: atropinic side effects are the major toxicity of imipraminics.

Stem –*triptyline* (-*tiline*) is used for "Antidepressants dibenzo[a,d] cycloheptane or cycloheptene derivatives"

All INNs with this stem belong to this pharmacologic class. *amitriptyline* (WHO Model List of Essential Mediciness) belongs to this class.

Example of common properties: atropinic side effects are the major toxicity of this class.

Selective serotonin reuptake inhibitors

Stem –*traline* is for "serotonin reuptake inhibitors"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *sertraline*.

Stem –*oxetine* is for "serotonin and/or norepinephrine reuptake inhibitors, fluoxetine derivatives"

All INNs with this stem belong to this pharmacological class. *fluoxetine* (WHO Model List of Essential Medicines) belongs to this class.

Examples of common properties All serotonin reuptake inhibitors can induce paradoxical agressivity and enhance suicidal risk. Nausea, vomiting and other gastro-intestinal disturbance are frequent.

Other antidepressants

Stem –*fensine* is used for "norepinephrine, serotonin, dopamine reuptake inhibitors

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *nomifensine*.

▪ *N06D anti-dementia drugs*

Cholinesterase inhibitors

Stem –*stigmine* is for "acetylcholinesterase inhibitors"

This stem is not useful for teaching because it is not specific for anti dementia drugs.

Stem –*crine* is for "acridine derivatives".

This stem is not useful for teaching because it is not specific.

Antagonists of NMDA-type glutamate receptor

Stem –*mantine* is for "adamantine derivative"

This stem is not useful for teaching because it is not specific.

Muscarinic receptor agonists

Stem –*meline* is used for "Cholinergic agents (muscarine receptor agonists/partial antagonists used in the treatment of Alzheimer's disease)"

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *xanomeline*.

▪ *N07 OTHER NERVOUS SYSTEM DRUGS*

Stem –*isant* is for "histamine H_3 receptor antagonists

All INNs with this stem belong to this pharmacological class. This stem was used the first time for *cipralisant*.

ANTIPARASITIC PRODUCTS, INSECTICIDES AND REPELLENTS

- ***P01 ANTIPROTOZOALS***

- ***P01A Antiprotozoals***

- ***P01AA Hydroxyquinoline derivatives***

  Stem *quine* is used for "quinolone derivatives" but is not specific. *amiodaquine, primaquine* (WHO Model List of Essential Medicines) belong to this class.

- ***P01AB Nitroimidazole derivatives***

  Stem *–nidazole* is used for "antiprotozoals and radiosensitizers metronidazole derivatives"

  All INNs with this stem belong to this pharmacological class. *metronidazole*, *miconazole* (WHO Model List of Essential Medicines) belong to this class.

  Examples of common properties: Azole derivatives are metabolized by cytochrome P450-dependent enzymes, which leads to many drug interactions.

- ***P01AC Dichloroacetamide derivatives***

  No common stem. *diloxanide* (WHO Model List of Essential Medicines) belongs to this class.

- ***P01B Antimalarials***

- ***P01BA Aminoquinolines***

  Stem *quine* is used for "quinolone derivatives" but is not specific for antimalarial. *chloroquine, mefloquine, hydroxychloroquine, oxamiquine* (WHO Model List of Essential Medicines) belong to this class.

- ***P01BD Diaminopyrimidines***

  No common stem

- ***P01BE Artemisin and derivatives***

  Stem *arte-* is for "antimalarial agents, artemisin related compounds"

  All INNs with this stem belong to this pharmacological class. *artemether, artenusate* (WHO Model List of Essential Medicines) belong to this list.

- ***P01C Agents against leishmanianis and trypanosomiasis***

- ***P01CD* Arsenic compounds**

  No common stem. *melarsoprol* (WHO Model List of Essential Medicines) belongs to this class.

- ***P02* ANTHELMINTICS**

  Stem –*antel* is used for "antihelminthics (undefined group)"

  All INNs with this stem belong to this pharmacological class. *praziquantel* (WHO Model List of Essential Medicines) belongs to this class.

  Stem –*bendazole* is used for "antihelminthics, tiabendazole derivatives"

  All INNs with this stem belong to this pharmacological class. *oxfendazole*, also belong to this class. *albendazole, benznidazole, mebendazole, triclabendazole* (WHO Model List of Essential Medicines) belong to this class.

  Stem –*ectin* is used for "antiparasitics, ivermectine derivatives"

  All INNs with this stem belong to this pharmacological class. *ivermectin* (WHO Model List of Essential Medicines) belongs to this class.

- ***P03* ECTOPARASITICIDES, INCL. SCABICIDES, INSECTICIDES AND REPELLENTS**

  No common stem

RESPIRATORY SYSTEM

- ***R03 DRUGS FOR OBSTRUCTIVE AIRWAY DISEASES***

- ***R03A Adrenergics, inhalants***

  Bronchodilators

  Beta$_2$ adrenergic agonists

  Stem *–terol* (previously –prenaline or –terenol unofficial)is for "bronchodilators, phenylethylamine derivatives"

  All INNs with this stem belong to this pharmacological class. *isoetarine, methoxyphenamine, salbutamol, salmefamol, terbutaline* also belong to this class without the stem. This stem was used the first time for *amiterol, fenoterol, rimiterol.*

- ***R03B Other drugs for obstructive airway diseases, inhalants***

  Muscarinic receptor antagonists

  Stem *–trop-* is used for "Atropine derivatives"

  somatropin, somatropin pegol, varfollitropin alfa do not belong to this class. This stem was used the first time for *eucatropine.*

- ***R03BC Antiallergic agents, excl. corticosteroids***

  Stem *cromil* is for "antiallergics, cromoglicic acid derivatives"

  All INNs with this stem belong to this pharmacological class. *cromoglicate* also belongs to this class. This stem was used the first time for *terbucromil.*

- ***R03C Adrenergics for systemic use***

- ***R03D Other systemic drugs for obstructive airway diseases***

  Stem *–ast* is for "antiasmathics or antiallergics, not acting primarily as antihistaminics"

  All INNs with this stem belong to this pharmacological class. This stem was used the first time for *loxanast, tranilast, zaprinast*

- ***R03DC Leukotriene receptor antagonists***

  Stem *–lukast* is for "leukotriene receptor antagonists"

  All INNS with this stem belong to this pharmacological class. This stem was used the first time for *tomelukast.*

- ***R06 ANTIHISTAMINES FOR SYSTEMIC USE***

▪ *R06A Antihistamines for systemic use*

H_1 receptor antagonists

Stem –*izine* (*yzine*) is for "diphenylmethyl piperazine derivatives"

This stem is not specific. *cyclizine* (WHO Model List of Essential Medicines) belongs to this class.

Stem –*astine* is used for "antihistaminics"

vinblastine is a cytostatic.

astemizole belongs to this pharmacological class. This stem was used the first time for *moxastine, perastine*.

Examples of common properties: H1 antihistaminics differ from one another by the intensity of their atropinic and sedative effects.

Stem –*tadine* is used for "antihistamine-H_1 receptor antagonists, tricyclic compounds"

This stem is not specific. *loratadine* (WHO Model List of Essential Medicines) belongs to this class.

SENSORY ORGANS

Drugs included in this chapter belong to pharmacological classes generally treated in other chapters.

Another important stems

Although not corresponding to specific pharmacologic classes, some stems are important to spot. The substances whose INNs contain these stems generally belong to the group of innovative therapies. These are the following stems:

-*cel* cell therapy

-*fusp* fusion proteins

-*gene* gene therapy products

-mab monoclonal antibodies

-*plasmid* gene therapy products

-*vec* gene therapy products

VARIOUS

Pharmacology is generally not concerned for drugs included in this chapter (allergens, general nutrients, contrast media, diagnostic radiopharmaceuticals)

ALIMENTARY TRACT AND METABOLISM

▪ *A02 DRUGS FOR ACID RELATED DISORDERS*

▪ *A02A Antiacids*

The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

▪ *A02B Drugs for peptic ulcer and gastro-oesophageal reflux disease (GORD)*

stem	definition	example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-tidine	Histamine H2 receptor antagonists, cimetidine derivatives	*ranitidine**	*azacitidine* (antineoplastic) *hexetidine* (disinfectant)	none
cimetidine and other H_2 antagonists can reduce the absorption of drugs whose absorption in dependent on an acid gastric pH.				
-prostil	Prostaglandins, anti-ulcer	*Deprostil* (a)	none	none
Prostaglandins are numerous and involved in many biological processes. Chemically very close prostaglandins can have very different properties. For example, *misoprostol* induces both uterine contractions and inhibits gastric secretion. It is used in gynecology and gastroenterology. Other prostaglandins are used for their vasodilator properties in glaucoma and erectile dysfunction.				
-prazole	Antiulcer, benzimidazole derivatives	*omeprazole**	none	none
Caution : stem *–piprazole* is used for psychotropics, phenylpiperazine derivatives Proton pump inhibitors are metabolized by cytochrome P450 system. They can affect the absorption of drugs whose absorption is dependent on an acid gastric pH.				

**INN belonging to WHO model list of essential medicines*

a- For the examples, when available drugs on the WHO Essential medicines list were chosen. When not available, the first drug on a chronological basis being allocated the stem is represented. Please note that the exemplified drug might not be the most representative and, in particular instances, may not have reached the market.

▪ *A03 DRUGS FOR FUNCTIONAL GASTROINTESTINAL DISORDERS*

The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

▪ *A04 ANTINAUSEANTS AND ANTI-EMETIC AGENTS*

stem	definition	example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-setron	Serotonin receptor antagonists (5-HT3) not fitting into other established groups of serotonin receptor antagonists	*ondansetron**	none	none
-pitant	Neurokinin NK1 (substance P) receptors antagonists	*dapitant*	none	none

Pharmacological without useful stem for teaching :

Anticholinergics

No specific stem.

Antihistamines which are often used as antiemetics, are classified in R06 – *Antihistamines for systemic use.*

Butyrophenones

Stem *–peridol* is used for "antipsychotics, haloperidol derivatives" and it is not possible to differentiate some of them used only as anti-emetics

Phenothiazines

There is no common stem for phenothiazines

Steroids

There is no stem for identifying steroids used only as anti-emetics

▪ *A05 BILE AND LIVER THERAPY*

The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

▪ *A06 DRUGS FOR CONSTIPATION*

Laxatives, cathartics

The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A07 ANTIDIARRHEALS, INTESTINAL ANTIINFLAMMATORY/ ANTIINFECTIVE AGENTS***

- ***A07A Intestinal antiinfectives.***

  This group comprises locally acting antiinfectives like *paronomycin* (WHO model list of essential medicines). Antiinfectives for systemic use, see J- *Antiinfectives for systemic use.*

- ***A07B Intestinal adsorbents***

  Used medicines are combinations with intestinal antiinfectives.

- ***A07C Electrolytes with carbohydrates***

  No medicine with INN

- ***A07D Antipropulsives***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties

- ***A07E Intestinal anti-inflammatory agents***

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-salazine	no definition	*sulfasalazine**	none	none

Thiopurine derivatives

No specific stem useful for teaching pharmacological properties.

Biological therapy

No specific stem useful for teaching pharmacological properties.

- ***A07F Antidiarrheal microrganisms***

  No medicine with INN.

- ***A08 ANTIOBESITY PREPARATIONS, EXCL. DIET PRODUCTS***

  The medicines in this section are very heterogeneous and it is not possible to find useful stems for teaching their pharmacological properties.

- ***A09 DIGESTIVES, INCL. ENZYMES***

  Stem a-*ase* used for "enzymes" is not useful because it is not specific.

- ***A10 DRUGS USED IN DIABETES***

- ***A10A Insulin and analogues***

  These medicines contain the name insulin + a second name

▪ *A10B* Blood glucose lowering drugs, excl. insulins

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-glitazone	Peroxisome proliferator activating receptor gamma agonists, thiazolinedione derivatives	*ciglitazone*	none	none
Glitazones reduce insulin resistance in type 2 diabetes. Some have had to be withdrawn from the market because of serious side effects.				
-gliptin	Dipeptidyl aminopeptidase-IV inhibitors	*saxagliptin*	none	none
Some adverse effects of gliptins which are incretin catabolism inhibitors are common with *exenatide* or *liraglutide* which are GLP-1 agonists. GLP-1 is a hormone of the incretin family.				
-glitazar	Peroxisome proliferator activating receptor gamma (PPAR-gamma) agonists	*farglitazar*	none	none
-gliflozin	Sodium glucose co-transporter inhibitors, phlorizin derivatives	*dapagliflozin*	none	none
Gliflozins increase the excretion of glucose in the urine. They expose to a risk of urinary and genital infections.				

Pharmacological classes without useful stem :

Biguanides

Stem *–formin* is used for "antihyperglycaemics, phenformin derivatives.

All INNs with this stem belong to this pharmacological class also named "biguanides. *metformin* (WHO model list of essential medicines) is the only member of the biguanide class available for use today.

Sulfonamides, urea derivatives (also called Sulfonylureas first generation)

No useful stem but these drugs are no more in use

Sulfonamides (heterocyclics) (Also called Sulfonylureas second generation)

Stem *gli* (gly) is used for " antihyperglycaemics" but it is not specific for sulfonylureas second generation. *Gliclazide* (WHO model list of essential medicines) belongs to this class

Alpha glucosidase inhibitors

Pharmaceutical substances in this class like *acarbose, miglitol* do not have a common stem.

GLP-1 agonists

GLP-1 agonists, like *exenatide* and *liraglutide* are peptides with stem –tide very imprecise.

A11 VITAMINS

Stem calci is for "vitamin D analogues derivatives"

Calcitonin does not belong to this pharmacological class.

A12 MINERAL SUPPLEMENTS

No INN.

A13 TONICS

In general mixtures with no INN.

A14 ANABOLIC AGENTS FOR SYSTEMIC USE

A14A anabolic steroids

Anabolic steroids used exclusively in cancer therapy, see L-Antineoplastic and immunomodulating agents.

BLOOD AND BLOOD FORMING ORGANS

▪ *B01* ANTITHROMBOTIC AGENTS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-arol	Anticoagulants, dicoumarol derivatives	*acenocoumarol*	none	*diarbarone, ethyl biscoumacetate, phenprocoumon, tecarfarin, warfarin*
The anticoagulant effect of antivitamin K is monitored by a blood test, the INR (Intenational Normalized Ratio). Antivitamin K are metabolized by CYP450 isoenzymes. Many pharmacokinetic interactions.				
-parin	Heparin derivatives including low molecular mass heparins	*enoxaparin**	none	none
There are two types of heparin thrombocytopenia. Moderate thrombocytopenia type I, which occurs within the first 5 days of treatment, and type II thrombocytopenia, severe, associated with thrombosis. Plaque monitoring is recommended during heparin therapy. The activity of the unfractionated heparins is measured by the partial thromboplastin time with activator. *Protamine sulfate* quickly neutralizes their anticoagulant effect. The activity of low molecular weight heparins is monitored by anti Xa activity				
-irudin	Hirudin derivatives	*desirudin*	none	none
desirudin and *lepirudin* are used for treating thrombosis in the setting of heparin induced thrombocytopenia				
-troban	Thromboxane A_2 receptor antagonists; antithrombotic agents	*sulotroban*	none	none
argatroban and others can be used for patients with or at risk of developing heparin induced thrombocytopenia				
-cogin	Blood coagulation cascade inhibitors	*tifacogin*	none	none
-grel	Platelet aggregation inhibitors	*clopidogrel**	none	none
Concomitant administration with an anticoagulant or non steroidal anti-inflammatory drug increases the risk of bleeding				
-pafant	Platelet-activating factor antagonists	*apafant, bepafant*	none	none
-gatran	Thrombin inhibitors, antithrombotic agents	*efegatran*	none	none
There is no test to monitor coagulation. *idarucizumab* is an antidote for *dabigatran*.				
-xaban	Blood coagulation factor X_A inhibitors, antithrombotics	*atamixaban*	none	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
There is no test to monitor coagulation or antidote for overdose.				
-fiban	Fibrinogen receptor antagonists(glycoprotein IIb/IIIa receptor antagonists)	*lamifiban*	none	none
The major side effect is bleeding and they may induce thrombocytopenia				

▪ *B02 ANTIHEMORRHAGICS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-poetin	Erythropoietin type blood factors	*epoetin alfa*	none	none

CARDIOVASCULAR SYSTEM

▪ *C01 CARDIAC THERAPY*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-afenone	Antiarrhythmics, propafenone derivatives	*etafenone*	none	none
-aj-	Antiarrhythmics, ajmaline derivatives	*prajmalium bitartrate*	none	none
-cain-	Class I antiarrhytmics	*bucainide*	none	none
-ilide	Class III antiarrhytmics, sematilide derivatives	*sematilide*	none	none
-isomide	Class I antiarrythmics disopyramide derivatives	*pentisomide*	none	none
-kalant	Potassium channel blockers	*almokalant*	none	none
The most widely used classification of antiarrythmics is that proposed by Vaughan Williams (later modified by Harrison) and is based largely on their *in vivo* electrophysiological effects. A major limitation of Vaughan Williams classification is that many antiarrhythmics have multiple actions and may not fit neatly into a single class. All antiarrhythmics have major cardiac side effects and many interactions.				
-rinone	Cardiac stimulants, amrinone derivatives	*amrinone*	none	none
-dan	Cardiac stimulants, pimobendan derivatives	*pimobendan*	none	none
Increased risk of arrhythmia and death are likely related to the PDE3 inhibitor effect of these substances				
-afil	Inhibitors of phospho-diesterase PDE5 with vasodilator action	*sildenafil*	none	none
PDE5 inhibitors have mainly cardiovascular and visual adverse effects. They expose to many pharmacokinetic interactions with CYPA3 inducers and inhibitors.				
-bradine	Bradycardic agents	*zatebradine*	none	none
-azosin	Antihypertensive substances, prazosin derivatives	*alfluzosin, tamsulosin, tipentosin*	none	none
Alpha-1 blockers are not recommended as monotherapy for hypertensive patients. They are attractive drugs for hypertensive patients with benign prostate hyperplasia because they also improve urinary symptoms				
-guan	Antihypertensives, guanidine derivatives	*guanethidine*	none	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-dralazine	Antihypertensives, hydralazine phtalazine derivatives	*hydralazine**	none	none
Many cardiovascular side effects linked to mechanism of action. These substances may induce immunological reactions like lupus syndrome				
-kalim	Potassium channel activators, antihypertensives	*cromakalim*	none	none
-ciguat	Guanylate cyclase activators and stimulators	*ataciguat, atriciguat*	none	none
-entan	Endothelin receptor antagonists	*bosentan*	none	none
-etanide	Diuretics (piretanide type)	*bumetanide*	none	none
-semide	Diuretics, furosemide derivatives	*furosemide*	none	none
-tizide	Diuretics, chlorothiazide derivatives	*altizide, butizide, epitizide*	none	14 INNs endind by *–thiazide* like *hydrochlorothiazide**
Thiazide diuretics are prone to hypokalemia, metabolic disorders (hyperglycemia, hyperuricemia with gout attacks), lipid disorders, photosensitization, erectile dysfunction, hypochloremic alkalosis.				
-renone	Aldosterone antagonists, spironolactone derivatives	*anrenone, dicirenone*	*teprenone* (gastric protection), *ubidecarenone* (antioxidant)	none
these diuretics expose to gynecomastia.				
-ritide	Natriuretic factor type substances	*anaritide*	none	none
-vaptan	Vasopressin receptor antagonists	*conivaptan, relcovaptan*	none	none
-dil, dilol	vasodilators	*benfurodil hemisuccinate*	*diloxanide* (amebicide), *methdilazine* (antihistaminic)	For *dilazep*, stem not at the end of INN
-alol, olol	Beta drenoreceptor antagonists	*bisoprolol, propranolol, timolol**	*stanozolol* (anabolic steroid)	
Beta blockers are competitive antagonists of catecholamines beta-adrenergic receptors in a wide range of tissues. Although they have broadly similar properties they differ in their affinity for $beta_1$ or $beta_2$ receptor subtypes, intrinsic sympathomimetic activity, membrane-stabilising activity, blockade of alpha-adrenergic receptors, and pharmacokinetic properties including differences in lipid solubility. These differences may affect the choice of drug in specific situations.				
-dipine	Calcium channel blockers, nifedipine derivatives	*nifedipine**	*bupidine* (antiparkinsonian)	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-tiazem	Calcium channel blockers, diltiazem derivative	*diltiazem*	none	none
-pamil	Calcium channel blockers, verapamil derivatives	*verapamil**	none	none
All calcium channel blockers are highly metabolized and sensitive to enzyme inducers				
-pril(at)	Angiotensin-converting enzyme inhibitors	*enalapril**	none	none
-sartan	Angiotensin II receptors antagonists, antihypertensive (non-peptidic)	*losartan**	none	none
-kiren	Renin inhibitors	*enalkiren*	none	none
Cough is a common undesirable effect with converting enzyme inhibitors, it seems less common under sartan. These drugs that act directly on the renin-angiotensin system have fetal adverse effects established during the last two trimesters of pregnancy: arterial hypotension, anuria, renal failure, oligoamnios, fetal death**.**				
-vastatin	Antihyperlipidaemic substances, HMG CoA reductase inhibitors	*simvastatin**	none	none
The commonest adverse effects of therapy with statins are gastrointestinal disturbances. Dose-related myopathy has been frequently reported.				
-fibrate	Clofibrate derivatives, peroxisome proliferator activated receptor α (PPARα) agonists	*simfibrate*	none	none
Some fibrates enhance the effects of *warfarine*. All fibrates increase the risk of biliary lithiasis.				
-imib	Antihyperlipidaemis, acylCoA : cholesterol acetyl transferase (ACAT) inhibitors	*octimibate*	none	none
-tapide	Microsomal triglyceride transfer protein (MTP) inhibitors	*implitapide*	none	none
-cetrapib	Cholesteryl ester transfer protein (CETP) inhibitors	*forcetrapib*	none	none

Pharmacological classes with no useful stem for teaching :

Alpha2 adrenoreceptor antagonists

INNs for these medicines have no common stem

Non selective alpha adrenergic antagonists

INNs in these medicines have no common stem.

Osmotic diuretics

INNs for these medicines have no common stems.

Osmotic diuretics raise the osmolality of plasma and renal tubular fluid. They are used to reduce or prevent cerebral oedema, to reduce raised intra-ocular pressure, and in acute renal failure.

▪ *C05 VASOPROTECTIVES*

Medicines in this group are very heterogeneous with no common stem.

Bile-acid sequestrants

The two established bile-acid sequestrants or resins (*cholestyramine* and *colestipol*) are among the oldest of hypolipidemic drugs.

Niacin (nicotinic acid)

Stem *nico-* or *nic-* or *ni-*is used for " nicotinic acid or nicotinoyl alcohol derivatives" but it is not useful because many drugs with various mechanisms of action contain this stem.

DERMATOLOGICALS

Most of drugs included in chapter "dermatologicals" are also treated in other chapters.

▪ *D05 ANTIPSORIATICS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-arotene	Arotinoid derivatives	*betacarotene*	none	none
-retin	Retinol derivatives	*tretinoin*	none	none
Animal studies have indicated that aratinoid derivatives and retinol derivatives are fetotoxic and teratogenic. Similarly, these drugs should not be used, or used with caution, during breast feeding, as animal data indicate that they may be distributed into breast milk.				

GENITO URINARY SYSTEM AND SEX HORMONES

▪ *G01* GYNECOLOGICAL ANTIINFECTIVES AND ANTISEPTICS

Drugs treated in other chapters.

▪ *G02* OTHER GYNECOLOGICALS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-erg	Ergot derivatives	*ergometrine**	*ergocalciferol* (vit D precursor)	*rotigotine*
-golide	Dopamine receptor agonists, ergoline derivative	*pergolide*	none	*rotigotine*
Ergot derivatives cause retroperitoneal fibrosis, pleuropulmonary fibrosis and cardiac valvulopathies. They cause vasoconstrictions with, among other things, aggravation of Raynaud's phenomena. They also cause compulsive disorders (pathological gambling, hypersexuality, ...).				
-prost-	prostaglandins	*misoprostol*	none	none
The pharmacological properties of prostaglandins are wide-ranging and include contraction or relaxation of smooth muscle in the blood vessels, bronchi, uterus, and gastrointestinal tract; inhibition of gastric acid secretion; and effects on platelet aggregation, the endocrine system and metabolic processes.				
-pris-	Steroidal compounds acting on progesterone receptors (excluding –gest- coumpounds)	*mifepristone**	none	none
Warning : stem *–pristin-* is selected for antibacterials.				
-siban	Oxytocin antagonists	*atosiban*	none	none

▪ *G03B* Androgens

Stem *–ster-* is used for androgen/ anabolic steroids" but also for "progestational steroids". This lack of specificity makes this stem not useful, even confusing, for teaching pharmacology

▪ *G04 UROLOGICALS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-begron	$Beta_3$ adrenoreceptor agonists	*talibegron*	none	none
-fenacin	Muscarinic receptors agonists	*tofenacin*	none	none
-afil	Inhibitors of phosphodiesterase PDE5 with vasodilator action	*vardenafil*	none	none
-steride	testosterone reductase inhibitors	*finasteride*	none	none

SYSTEMIC HORMONAL PREPARATIONS, EXCL. SEX HORMONES AND INSULINS

▪ *H01 PITUITARY AND HYPOTHALAMIC HORMONES AND ANALOGUES*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-relin	Pituitary hormone-release stimulating peptides	*leuprorelin**	none	none
-actide	Synthetic plypeptides with a corticotropin-like action	*tetracosactide*	none	none
-morelin	Growth hormone release-stimulating peptides	*sermorelin*	none	none
-tirelin	Thyrotropin releasing analogues	*protirelin*	none	none
-pressin	Vasoconstrictors, vasopressin derivatives	*desmopressin**	none	none
-relix	Gonadotropin-releasing hormone (GnRH) inhibitors, peptides	*detirelix*	none	none

Natural and recombinant gonadotropins

-tropin is not a stem. They would have a risk of confusion with stem –*trop*- (atropine derivatives)

▪ *H02 CORTICOSTEROIDS FOR SYSTEMIC USE*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
cort	Corticosteroids, except prednisolone derivatives	*cortisone*	*clorocortone, difluocortone, fluocortolone, halocortone* **are** *prednisolone* **derivatives**	none
-pred	Prednisone and prednisolone derivatives	*prednisolone**	none	none
-onide	Steroids for topical use, acetal derivatives	*budesonide**	none	*amcinafal*

The corticosteroids are traditionally divided into those with mainly glucocorticoid actions and those that are mainly mineralocorticoids. Corticosteroids are usually contra-indicated in the presence of acute infections uncontrolled by appropriate antimicrobial therapy.

The risk of systemic absorption should always be considered when applying corticosteroid topically.

Inhibitors of the biosynthesis and action of adrenocortical steroid
Medicines in this class are very heterogeneous with no common stem.

- ***H03 THYROID THERAPY***

No common stem

Anti-thyroid drugs and others thyroid inhibitors
No common stem

- ***H04 PANCREATIC HORMONES***

No common stem

- ***H05 CALCIUM HOMEOSTASIS***

No common stem

ANTIINFECTIVES FOR SYSTEMIC USE

▪ *J01 ANTIBACTERIALS FOR SYSTEMIC USE*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-cycline	Antibiotics, protein-synthesis inhibitors, tetracycline derivatives	*doxycycline, tetracycline, tigecycline**	none	none
Tetracyclines all have a broad spectrum of activity but the emergence of resistant strains has often reduced their value. Gastrointestinal disturbances are common and other important toxic effexfs include deposition in bones and teeth, precluding their use in pregnancy and young children.				
-cillin	Antibiotics, 6-aminopenicillanic acid derivatives	*benzylpenicillin, cloxacillin**	none	none
Hypersensitivity reactions are by far the most common side effects and these agents are amongst the most common causes of drug allergy				
cef-	Antibiotics, cefalosporanic acid derivatives	*cephalexin, cefazolin, cefepime, cefixime, cefotaxime, ceftaroline, ceftazidime, ceftriaxone**	none	none
The most widely used system of classification of ce^phalosporins is by generations and is based on the general features of their antibacterialactivity, but may depend to some extent on when they were introduced. Succeeding generations generally have increasing activity against gram-negative bacteria.				
-bactam	Beta-lactamase inhibitors	*sulbactam*	none	*clavulanic acid*
-kacin	Antibiotics, kanamycin and bekanamycin derivatives	*amikacin**	none	*dihydrostreptomycin, streptomycin, apramycin, kanamycin, nebramycin, tobramycin*
All aminoglycosides have the potential to produce reversible and irreversible ototoxicity, renal toxicity and neuromuscular blockade				
sulfa-	Anti-infectives, sulphonamides	*sulfapyridine*	*galsulfase, idursulfase* **are enzymes and not antibiotics.**	many
-prim	Antibacterials, dihydrofolate reductase(DHFR) inhibitors, trimethoprim derivatives	*trimethoprim**	none	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-pristin	Antibacterials, streptogramins, protein synthesis inhibitors, pristinamycin derivatives	*quinupristin*	none	none
-oxacin	Antibacterials, nalidixic acid derivatives	*ciprofloxacin, levofloxacin, moxifloxacin, ofloxacin**	none	*Flumequine, nalidixic acid, oxolinic acid, pipemidic acid, piromidic acid, metioxate*
Fluoroquinolones can cause sometimes severe neuropsychic disorders, prolongation of the QT interval, and joint damage in growing animals. They are to be avoided in pregnant women and children.				
-zolid	Oxazolidinone antibacterials	*Linezolid**	none	none
-planin	Glycopeptide antibacterials (Actinoplanes strains)	*actaplanin*	none	none

Pharmacological classes without useful stem:

Amphenicols

Phenicol is not a stem. *Chloramphenicol* (WHO model list of essential medicines) belongs to this class.

Aminoglycosides antibacterials

Stem *–mycin* is used for "antibiotics, produced by Streptomyces strains" but is not specific because it is also used for other antibiotics and antineoplastics.

Examples of common properties *:* The aminoglycosides have broadly similar toxicological features. Ototoxicity is a major limitation to their use. Aminoglycosides should in general only be used for the treatment of serious infections because of their potential toxicity and antimicrobial spectrum.

Spectinomycin (WHO model list of essential medicines) belongs to this class.

Macrolides, lincosamides and streptogramins.

Macrolides and ketolides

Stem *–mycin* is used for "Antibiotics, produced by Streptomyces strains" but it is not specific

Azithromycin (WHO model list of essential medicines) belong to this class.

Examples of common properties Except for *spiramycin*, macrolides have many risks of pharmacokinetic interactions.

Lincosamide

Stem –mycin (not specific) *clindamycin* (WHO model list of essential medicines) belong to this class.

Aminoglycoside antibacterials

No specific stem

Other antibacterials

Aminocyclitols

Stem –mycin (not specific)

Polymyxins

Substances in this class do not have common stem.

Colistin (WHO model list of essential medicines) belong to this class.

▪ *J02 ANTIMYCOTICS FOR SYSTEMIC USE*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-conazole	Systemic antifungal agents, miconazole derivatives	*fluconazole, itraconazole, voriconazole**	*Bifonazole, isavuconazonium chloride*	
All miconazole derivatives are substrates and inhibitors of isoenzymes CYPS. They have many drug interactions				
-fungin	Antifungal antibiotics	*fusafungin*	none	none

▪ *J04 ANTIMYCOBACTERIALS*

Many antimycobacterials included in WHO model list of essential medicines have no common stem : *bedaquilline, clofazimine, cycloserine, ethionamide, ethambutol, isoniazid, pyrazinamide.*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
rifa-	Antibiotics, rifamycin derivatives	*rifabutin, rifampicine**	none	none
-dapsone	Antimycobacterials, diamino diphenylsulfone derivatives	*dapsone**	none	none

Aminoglycosides

INNs in this class have no common stem.

▪ *J05 ANTIVIRALS FOR SYSTEMIC USE*

Anti-herpes virus agents

No specific stem. *Aciclovir* (WHO model list of essential medicines) belongs to this class.

Anti-influenza agents

Stem –mantadine adamantine derivatives

This stem is not specific for antiviral agents.

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-previr	Hepatitis virus (VHC) protease inhibitors	*simeprevir*	none	none
-virine	Non nucleotide reverse transcriptase inhibitors	*emivirine, rilpivirine*	none	none
-navir	HIV protease inhibitors	*atazanavir, darunavir, lopinavir, ritonavir**	none	none
-viroc	CCR5 (Chemokine CC motif receptor 5) receptor antagonists	*ancriviroc*	none	none

Nucleoside and nucleotide inverse transcriptase inhibitors

No specific stems

Stems *vir*, *vudine* and *citabine* are not specific for antiretroviral agents. *Zidovudine* (WHO model list of essential medicines) belongs to this class.

ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS

▪ *L01 ANTINEOPLASTIC AGENTS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-fosfamide	Alkylating agents of the cyclophosphamide group	*cyclophosphamide, ifosfamide**	none	none
-sulfan	Antineoplastics, alkylating agents, methasulfonates	*busulfan*	none	none
-tepa	Antineoplastics, thiotepa derivatives	*thiotepa*	none	none
-mustine	Antineoplastic, alkylating agents, (beta-chloroethyl) amine derivatives	*bendamustine**	none	Many INNs
-platin	Antineoplastic agents, platinium derivatives	*carboplatin, cisplatin, oxaliplatin**	none	none
Platinium salts are nephrotoxics and produce severe nauseas and vomitings				
-trexate	Folic acid analogues	*methotrexate*	none	none
The primary toxicity of antifolates are on the bone marrow and the intestinal epithelium				
-trexed	Antineoplastics, thymidylate synthetase inhibitors	*pemetrexed, nolatrexed*	none	*none*
-(a)rabine	Arabinofuranosyl derivatives	*cytarabine, fludarabine**	none	*ribavirin, taribavirin*
-taxel	Antineoplastics, taxane derivatives	*docetaxel, paclitaxel**	none	none
Taxanes commonly cause peripheral neuropathy				
-tecan	Antineoplastics, topoisomerase I inhibitors	*Irinotecan**	none	none
-rubicin	Antineoplastics, daunorubicin derivatives	*daunorubucin, doxorubicin**	none	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
daunorubicin **and other anthracyclines cause pronounced bone-marrow depression which may be dose-limiting. The anthracyclines produce cardiotoxicity. Severe cardiotoxicity is linked to total cumulative doses.**				
-antrone	Antineoplastics, anthraquinone derivatives	*mitoxantrone*	none	none
-bulin	Antineoplastics, mitotic inhibitors, tubulin binders	*mivobulin*	*thyroglobulin*	none
Tubulin binders commonly cause peripheral neuropathy				
mito-	Antineoplastics, nucleotoxic agents	*mitogillin, mitopodozide, mitotenamine*	none	none
-parib	Poly-ADP-ribose polymerase inhibitors	*olaparib*	none	none
-rafenib	Raf(rapidely accelerated fibrosarcoma) kinase inhibitors	*sorafenib*	none	none
-tansine	Maytansinoid derivatives, antineoplastics	*maitansine*	none	none
-tinib	Tyrosine kinase inhibitors	*erlotinib, gefitinib*	none	none
-anib	Angiogenesis inhibitors	*vatalanib*	none	none
Angiogenesis inhibitors have a common profile of side effects				
-sertib	Serine/threonine kinase inhibitors	*danusertib*	none	none
-zomib	Proteasome inhibitors	*bortezomib*	none	none
-leukin	Interleukin-2 analogues and derivatives	*aldesleukin*	none	none

Pharmacological classes without useful stem for teaching:

Triazenes

No stem

Pyrimidine analogs

Not specific stems

–ur –uridine uridine derivatives used as antiviral agents and as antineoplastics

These stems are not specific : antiviral or antineoplastic agents. *fluorouracil* (WHO model list of essential medicines) belongs to this class.

Cytidine analogs

Not specific stem .

-citabine nucleosides antiviral or antineoplastic agents, cytarabine or azacitidine derivatives. *capecitabne* (WHO model list of essential medicines) belongs to this class.

Vinca alkaloids

Stem *vin-* is used for "vinca alkaloids" but is not useful because it is used for antineoplastics, "stimulators" of cerebrovascular circulation**.** *Vinblastine, vincristine, vinorelbine* (WHO model list of essential medicines) belong to this class.

Podophyllotoxin derivatives

No common stem. *Etoposide* (WHO model list of essential medicines) belongs to this class.

Epothilones

No stem

▪ *L02 ENDOCRINE THERAPY*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-ifene	Antiestrogens or estrogen receptor modulators, clomifene and tamoxifen derivatives	*clomifene**	none	none
-lutamide	Non steroid antiandrogens	*bicalutamide**	*aceglutamide*	none
-mestane	Aromatase inhibitors	*atamestane*	none	none
-rozole	Aromatase inhibitors, imidazole-triazole derivatives	*fadrozole, liarozole, vorozole*	*sulfatrozole, aminotrozole, tenonitrozole*	none

▪ *L03 IMMUNOSTIMULANTS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-stim	Colony stimulating factors	*filgrastim**	none	none
-imod	Immunomodulators, both stimulant/ suppressive and stimulant	*tiprotimod*	none	none

▪ *L04* Immunosuppressants

Calcineurin inhibitors

No useful stem.

Antiproliferative and antimetabolic drugs

Stem *–imus* is for "immunosuppressants (other than antineoplastics)"

Monoclonal antibodies

Stem *–mab* is for " monoclonal antibodies".

This stem is not specific for antineoplastics.

MUSCULO-SKELETAL SYSTEM

▪ *M01* ANTIINFLAMMATORY AND ANTIRHEUMATIC PRODUCTS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-ac	Anti-inflammatory agents, ibufenac derivatives	*diclofenac*	none	*amtometin guacil, clamidoxic acid, fenclozic acid, metiazinic acid, prodolic acid, tolmetin*
-fenamic	Anti-inflammatory anthranilic acid derivatives	*clofenamic acid, flufenamic acid, mefenamic acid*	none	none
-fenamate	Fenamic acid derivatives	*colfenamate, etofenamate*	none	none
-coxib	Selective cyclo-oxygenase inhibitors	*celecoxib, deracoxib, parecoxib, rofecoxib, valdecoxib*	none	none
Selective COX-2 inhibitors are associated with a lower incidence of serious gastrointestinal effects than the traditional NSAIDS but they can induce severe cardiovaxcular effects				
-icam	Anti-inflammatory, isoxicam derivatives	*isoxicam*	none	none
-metacin	Anti-inflammatory, indomethacin derivatives	*indometacin*	none	**none**
-profen	Anti-inflammatory agents, ibuprofen derivatives	*ibuprofen**	none	**none**
It is considered that there are only small differences in anti-inflammatory activity between the various NSAIDS and choice is largely empirical. Due to their ant-prostaglandins activity NSAIDS use have to be avoided during all pregnancy.				

▪ *M02* TOPICAL PRODUCTS FOR JOINT AND MUSCULAR PAIN

▪ *M03* MUSCLE RELAXANTS

Neuromuscular blocking agents

No stem is useful

Stem *–ium* is used for " Quaternary ammonium compounds" but INNs including stem *–ium* can be used for neuromuscular blocking agents, cholinergic agents, anticholinergic agents, surfactants used as antibacterial and antiseptics, other agents.

▪ *M04* ANTIGOUT PREPARATIONS

INNs in this class are heterogeneous without common stem. a*llopurinol* (WHO model list of essential medicines) belongs to this class.

▪ *M05* DRUGS FOR TREATMENT OF BONE DISEASES

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-dronic acid	Calcium metabolism regulators, pharmaceutical aid	*zoledronic acid*	none	none
Biphosphonates may cause peptic ulcerations. Osteonecrosis of the jaw has been reported.				

Calcium sensor mimetics : cinacalcet

INNs in this class are heterogeneous without common stem.

NERVOUS SYSTEM

▪ *N01 ANESTHETICS*

Parenteral anesthetics

No common stem

Absence of stem is not a problem. It is a marginal very specialized chapter of pharmacology.

Inhalational anesthetics

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-flurane	Halogenated compounds used as general inhalation anaesthetics	*halothane**	***apaflurane***	***fluroxene, halothane***
-caine	Local anesthetics	*bupivacaine, lidocaine, tetracaine**	none	*dyclonine*

▪ *N02 ANALGESICS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-orphan, -orph-, -orphinol,-orphone	Opioid receptor antagonists/agonists, morphinan derivatives	*morphine**	*emorfazone* **(anti-inflammatory)**, *orphenadrine* **(antiparkinsonian)**	none
-azocine	Narcotic antagonists/ agonists related to 6,7-benzomorphan	*phenazocine*	none	none
-adol	analgesics	*acetyl-methadol, alphacetyl-methadol, alpha-methadol, betacetyl-methadol, betameth-adol*	*alfadolone* **(general anesthetic)**, *nadolol* **(beta blocker)**, *quinestradol* **(estrogen)**	none
-fentanil	Opioid receptor agonists, analgesics, fentanyl derivatives	*fentanyl**	none	none

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
nal-	Opioid receptor antagonists/agonists related to normorphine	*naloxone**	*nalidixic acid* **(antibacterial)**	none
-triptan	Serotonin ($5HT_1$) receptor agonists, sumatriptan derivatives	*oxitriptan*	none	none
Overuse of triptans and analgesics to treat headache or migraine can lead to dependence and paradoxical chronic daily headache. Triptans should not be used for prophylaxis but only for treatment of acute episodes.				

Pharmacological classes without useful stem :

Meperidine, diphenoxylate, loperamide

No common stem. *loperamide* is included in WHO model list of essential medicines.

▪ *N03 ANTIEPILEPTICS*

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-toin	Antiepileptics, hydantoin derivatives	*phenytoin**	*nitrofurantoin* **(antibacterial)**	none
Gingival hypertrophy is a classic side effect of hydantoins.				
-ampanel	Antagonists of the ionotropic non-NMDA (N-methyl-D-aspartate) glutamate receptor	*talampanel*	none	none

Pharmacological classes without useful stem for teaching :

Iminostilbenes

Stem –zepine is for "tricyclic anticonvulsivants"

Stem-*zepine* is not specific: it is used also for antiulcers and antidepressants/ neuroleptics. So it is not useful for learning. *Carbamazepine* (WHO model list of essential medicines) belongs to this class.

Succinimides

No stem. *ethosuximide* (WHO model list of essential medicines) belongs to this class.

▪ *N04* ANTI-PARKINSON DRUGS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-golide	Dopamine receptors agonists, ergoline derivative	*pergolide*	none	none
Fibrotic reactions such as cardiac valvulopathy and pleuropulmonary effusion have been reported with ergot derivatives				
-dopa	Dopamine receptor agonists, dopamine derivatives, used as antiparkinsonism/ prolactin inhibitors	*methyldopa*	none	none
-capone	Catechol-O-methyltransferase (COMT) inhibitors	*nitecapone*	none	none
-giline	Monoamine oxidase (MAO)-inhibitors type B	*clorgiline*	none	none

Muscarinic receptor antagonists

Stem –*mantadine* is for " adamantine derivatives". This stem is not useful because it is used for antivirals, antiparkinsonian and immunostimulants.

▪ *N05* PSYCHOLEPTICS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-peridol	Antipsychotics, haloperidol derivatives	*haloperidol*	none	none
haloperidol derivatives do not induce atropinic side effects				
-peridone	Antipsychotics, risperidone derivatives	*risperidone**	none	none
-azepam	Diazepam derivatives	*diazepam, lorazepam**	none	none
Benzodiazepine were widely used until 1980 years when tolerance and dependence, amnesia/automatism phenomena were described				
-clone	Hypnotic tranquillizers	*barbexaclone*	none	none
-pidem	Hypnotics/sedatives, zolpidem deivatives	*alpidem, zolpidem*	none	none
-plon	Imidazopyrimidine or pyrazolopyrimidine derivatives, used as anxiolytics, sedatives, hypnotics	*divaplon, fasiplon, taniplon*	none	none

Stem –apine is for " psychoactive"

Stem –apine cannot be used for teaching neuroleptics because it is a very heterogeneous group with also antidepressants for example

▪ *N06* PSYCHOANALEPTICS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-pramine	Substances of the imipramine group	*clomipramine**	none	*Carbamazepine, opipramol*
Atropinic side effects is the major toxicity of imipraminics				
-triptyline	Antidepressants dibenzo[a,d] cycloheptane or cycloheptene derivatives	*amitriptyline**	none	none
Atropinic side effects is the major toxicity of these substances				
All Tricyclic antidepressants produce the classic atropinic syndrome.				
-traline	Serotonin reuptake inhibitors	*sertraline*	none	none
-oxetine	Serotine and/or norepinephrine reuptake inhibitors, fluoxetine derivatives	*fluoxetine*	none	none
All serotonin reuptake inhibitors can induce paradoxical agressivity and enhance suicidal risk. Nausea, vomiting and other gastro intestinal disturbances are frequent.				
-fensine	Norepinephrine, serotonin, dopamine reuptake inhibitors	*nomifensine*	none	none

N07 OTHER NERVOUS SYSTEM DRUGS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-meline	Cholinergic agents (muscarine receptor agonists/partial antagonists used in treatment of Alzheimer's disease	*xanomeline*	none	none
-isant	Histamine H_3 receptor antagonists	*cipralisant*	none	none

Pharmacological classes without useful stem for teaching :

Cholinesterase inhibitors

Stem –*stigmine* is for " acetylcholinesterase inhibitors"

This stem is not useful for teaching because it is not specific for anti dementia drugs.

Stem –*crine* is for " acridine derivatives".

This stem is not useful for teaching because it is not specific.

Antagonists of NMDA-type glutamate receptor

Stem –*mantine* is for " adamantine derivative"

This stem is not useful for teaching because it is not specific.

ANTIPARASITIC PRODUCTS, INSECTICIDES AND REPELLENTS

▪ *P01* ANTIPROTOZOALS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-nidazole	Antiprotozoals and radiosensitizers metronidazole derivatives	*metronidazole, miconazole**	none	none
azole derivatives are metabolized by cytochrome P450-dependent enzymes, which leads to many drug interactions.				
arte-	Antimalarial agents, artemisin related compounds	*artemether, artenusate**	none	none

Pharmacological classes without useful stem for teaching :

Dichloroacetamide derivatives

No common stem. *Diloxanide* (WHO model list of essential medicines) belongs to this class.

Diaminopyrimidines

No common stem.

Arsenic compounds

No common stem. *melarsoprol* (WHO model list of essential medicines) belongs to this class.

▪ *P02* ANTIHELMINTICS

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-antel	Antihelminthics	*praziquantel**	none	none
-bendazole	Antihelminthics, tiabendazole derivatives	*albendazole, benznidazole, mebendazole, triclabendazole**	none	none
-ectin	Antiparasitics, ivermectin derivatives	*ivermectin**	none	none

RESPIRATORY SYSTEM

▪ *R03* DRUGS FOR OBSTRUCTIVE AIRWAY DISEASES

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-terol	Bronchodilators, phenylethylamine derivatives	*amiterol, fenoterol, rimiterol*	none	*isoetarine, methoxyphenamine, salbutamol, salmefamol, terbutaline*
-trop-	*Atropine derivatives*	*eucatropine*	*somatropin, somatropin pegol, varlifollitropin alfa*	none
-cromil	Antiallergics, cromoglicic acid derivatives	*terbucromil*	none	*cromoglicate*
-ast	Antiamathics or antiallergics, not acting primaly as antihistaminics	*loxanast, tranilast, zaprinast*	none	none
-lukast	Leukotriene receptor antagonists	*tomelukast*	none	none

▪ *R06* ANTIHISTAMINES FOR SYSTEMIC USE

stem	definition	Example	INN with this stem belonging to another pharmacological class	INN belonging to this class without the stem
-astine	antihistaminics	*moxastine, perastine*	*vinblastine* **(cytostatic)**	*astemizole*
H1 antihistaminics differ from one another by the intensity of their atropinic and sedative effects				

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