SCHOOL OF INN

Learning clinical pharmacology with the use of INNs and their stems
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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**

![Diagram showing the layout of information with sub-stems and chemical structures.]

- **Stem classification**: calci
- **Stem defintion**: Vitamin D analogues/derivatives
- **National Name(s)**: USAN
- **Graphic Formula**
  - alfaalcacidol (40), calcifediol (26), calcipotriol (61), calcitriol (39),
  - colecalciferol (13), doxercalciferol (82), ergocalciferol (13),
  - falcalcitriol (74), lexacalcitol (71), macacalcitol (75), paracalcitriol (78),
  - secalciferol (62), secalcitol (78), taacalcitol (65)
- **INN (English)**
- **List of proposed INN**
  - (b) calcitonin (31) (polypeptide)
  - (c) dihydrotachysterol (1)

**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 beta3 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, antisepsics 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 medicine 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 group 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 \( \text{H}_2 \)-receptor antagonists**
  Stem – *tidine* is used for “Histamine \( \text{H}_2 \) 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 \( \text{H}_2 \)-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 “psychoptics, 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 paromomycin (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 microorganisms
  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 Sulfonylamides, urea derivatives (also called Sulfonylureas first generation)**
  No useful stem but these drugs are no more in use

- **A10BC Sulfonylamides (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 Thiazolidinediones**
  Stem –*glitazone* is used for “peroxisome proliferator activating receptor gamma agonists, thiazolidinedione 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 Dipeptidyl 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 farglitzar.
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”
Calcitinin 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*. 

Learning clinical pharmacology
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<sub>a</sub> 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 antithrombic 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 *morococog 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 “Antiarythmics, 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 “antiarythmics, 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 antiarythmics”
  
  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 antiarythmics, 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:** Antiarythmics (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 antiarythmic properties and thus, have a wide range of other clinical applications.

  The most widely used classification of antiarythmics 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 antiarythmics have multiple actions, and may not fit neatly into a single class.

  All antiarythmics 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.

- **CO1D Vasodilators used in cardiac diseases**
  Stem – *afil* is for “inhibitors of phosphodiesterase PDE5 with vasodilator action”

All INNs 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, 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 monotherapy for hypertensive patients. They are attractive drugs for hypertensive patients with benign prostate hyperplasia because they also improve urinary symptoms.

  **Alpha, adrenoceptor 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. This 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 belong 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.

Inhibitors of the non specific cation channel: atrial natriuretic peptides
Stem – ridade is for “natriuretic factor type substances”

β-adrenergic receptors at beta-adrenergic receptors in a wide range of tissues. Although they have broadly similar properties they differ in their affinity for beta₁ or beta₂ 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 channel 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 and 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 a (PPARa) 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 *torcetrapib*.
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**
  
  - **C02AB 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. *rotigotine* 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, 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. *leuprolrelin* (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 –*morrelin* 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 –*trelrelin* 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 –*relies* 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 glycyclycines*
    
    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 *ceftazidime* 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 used 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*.

• **J01G 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.

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.

- **J01E Sulfonamides and trimethoprim**

  Stem *sulfa*- is used 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.

  **Lincosamide**

  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**

  No specific stem
- **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 used 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 except for *bifonazole* and *isavuconazonium chloride*. *fluconazole, itraconazole, voriconazole* (WHO Model List of Essential Medicines) belongs to this class.

  **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. *acyclovir* (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) belongs 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 DCi 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 –*rubin* 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.

    **Anthracenides**

    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”

  *thryoglobulin* 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 –inod (-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, fencloxic acid, metiazinnic 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 sans 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"
  apafurane does not belong to this class. fluroxene and halothane belong to this class without the stem. isofurane (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 orphar, -orph-, -orphinol, -orphone is for "opioid receptor antagonists/agonists, morphinan derivatives"
  emorphazone 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 –fentanyl 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,) 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-methyl6D-aspartate) glutamate receptor (namely the AMPA ‘amino-hydroxy-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 *talampine*.

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**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-methyltransferase (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 *nitechapone*.

**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.

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**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” neroleptics.

- **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 – _triptiline (tiline)_ is used for “Antidepressants dibenzo[a,d]cyproheptane or cycloheptene derivatives”
  All INNs with this stem belong to this pharmacologic class. _amitriptyline_ (WHO Model List of Essential Medicines) 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 – lisant** is for “histamine H₃ 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. *amodiaquine, 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**
  
  **Beta₂ 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, methoxyphephamine, salbutamol, salmefamol, terbutaline* also belong to this class without the stem. This stem was used the first time for *amiterol, fenoterol, rimeterol.*

- **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 “antiasmatics 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**

**H₁ 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-H₁ 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)*

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-tidine</td>
<td>Histamine H2 receptor antagonists, cimetidine derivatives</td>
<td>ranitidine*</td>
<td>azacitidine (antineoplastic)</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hexetidine (disinfectant)</td>
<td>none</td>
</tr>
</tbody>
</table>

*INN belonging to WHO model list of essential medicines

- 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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-setron</td>
<td>Serotonin receptor antagonists (5-HT3) not fitting into other established groups of serotonin receptor antagonists</td>
<td>ondansetron*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-pitant</td>
<td>Neurokinin NK1 (substance P) receptors antagonists</td>
<td>dapitan</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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 ANTIDARRHEALS, INTESTINAL ANTIINFLAMMATORY/ANTIINFECTIVE AGENTS**

- **A07A Intestinal antiinfectives.**
  This group comprises locally acting antiinfectives like paromomycin (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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-salazine</td>
<td>no definition</td>
<td>sulfasalazine*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

  **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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-glitazone</td>
<td>Peroxisome proliferator activating receptor gamma agonists, thiazolidinedione derivatives</td>
<td>ciglitazone</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-gliptin</td>
<td>Dipeptidyl aminopeptidase-IV inhibitors</td>
<td>saxagliptin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-glitazar</td>
<td>Peroxisome proliferator activating receptor gamma (PPAR-gamma) agonists</td>
<td>farglizar</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-gliflozin</td>
<td>Sodium glucose co-transporter inhibitors, phlorizin derivatives</td>
<td>dapagliflozin</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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

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.

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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-arol</td>
<td>Anticoagulants, dicoumarol derivatives</td>
<td>acenocoumarol</td>
<td>none</td>
<td>diarbarone, ethyl biscoumacetate, phenprocoumon, tecarfarin, warfarin</td>
</tr>
<tr>
<td>-parin</td>
<td>Heparin derivatives including low molecular mass heparins</td>
<td>enoxaparin*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-irudin</td>
<td>Hirudin derivatives</td>
<td>desirudin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-troban</td>
<td>Thromboxane A&lt;sub&gt;2&lt;/sub&gt; receptor antagonists; antithrombotic agents</td>
<td>sulotroban</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-cogin</td>
<td>Blood coagulation cascade inhibitors</td>
<td>tifacogin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-grel</td>
<td>Platelet aggregation inhibitors</td>
<td>clopidogrel*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-paffant</td>
<td>Platelet-activating factor antagonists</td>
<td>apafant, bepafant</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-gatran</td>
<td>Thrombin inhibitors, antithrombotic agents</td>
<td>efegatan</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

The anticoagulant effect of antivitamin K is monitored by a blood test, the INR (International Normalized Ratio). Antivitamin K are metabolized by CYP450 isoenzymes. Many pharmacokinetic interactions.

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.

Desirudin and lepirudin are used for treating thrombosis in the setting of heparin induced thrombocytopenia.

Argatroban and others can be used for patients with or at risk of developing heparin induced thrombocytopenia.

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

Idarucizumab is an antidote for dabigatran.
There is no test to monitor coagulation or antidote for overdose.

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-fiban</td>
<td>Fibrinogen receptor antagonists (glycoprotein IIb/IIIa receptor antagonists)</td>
<td>lamifiban</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

The major side effect is bleeding and they may induce thrombocytopenia

### B02 ANTIHEMORRHAGICs

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-poetin</td>
<td>Erythropoietin type blood factors</td>
<td>epoetin alfa</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
# CARDIOVASCULAR SYSTEM

## C01 CARDIAC THERAPY

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-afenone</td>
<td>Antiarrhythmics, propafenone derivatives</td>
<td>etafenone</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-aj-</td>
<td>Antiarrhythmics, ajmaline derivatives</td>
<td>prajmalium bitartrate</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-cain-</td>
<td>Class I antiarrhythmics</td>
<td>bucanide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-ilide</td>
<td>Class III antiarrhythmics, sematilide derivatives</td>
<td>sematilide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-isomide</td>
<td>Class I antiarrhythmics, disopramide derivatives</td>
<td>pentisomide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-kalant</td>
<td>Potassium channel blockers</td>
<td>almokalant</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

The most widely used classification of antiarrhythmics 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 phosphodiesterase PDE5 with vasodilator action | sildenafil| none                                                          | none                                          |

PDE5 inhibitors have mainly cardiovascular and visual adverse effects. They expose to many pharmacokinetic interactions with CYP3A inducers and inhibitors.

| -bradine| Bradycardic agents                                     | zatebradine| none                                                          | none                                          |
| -azosin| Antihypertensive substances, prazosin derivatives      | alfuzosin, tamsulosin, tipeptosin | 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

<p>| -guan   | Antihypertensives, guanidine derivatives              | guanethidine| none                                                          | none                                          |</p>
<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-dralazine</td>
<td>Antihypertensives, hydralazine phthalazine derivatives</td>
<td>hydralazine*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-kalim</td>
<td>Potassium channel activators, antihypertensives</td>
<td>cromakalim</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-cigut</td>
<td>Guanylate cyclase activators and stimulators</td>
<td>atacigut, atricigut</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-entan</td>
<td>Endothelin receptor antagonists</td>
<td>bosentan</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-etanide</td>
<td>Diuretics (piretanide type)</td>
<td>bumetanide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-semide</td>
<td>Diuretics, furosemide derivatives</td>
<td>furosemide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-tizide</td>
<td>Diuretics, chlorothiazide derivatives</td>
<td>altizide, butizide, epitolizide</td>
<td>none</td>
<td>14 INNs ending by -thiazide like hydrochlorothiazide*</td>
</tr>
</tbody>
</table>

Many cardiovascular side effects linked to mechanism of action. These substances may induce immunological reactions like lupus syndrome.

| -renone  | Aldosterone antagonists, spironolactone derivatives                         | anrenone, dicirenone | teprenone (gastric protection), ubidecarenone (antioxidant) | none                                          |
| -ritide  | Natriuretic factor type substances                                          | anaritide          | none                                                        | none                                          |
| -vaptan  | Vasopressin receptor antagonists                                            | conivaptan, relcovaptan | none                                                        | none                                          |
| -dil, dilol | vasodilators                                         | benfurodil hemisuccinate | diloxanide (amebicidal), 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, or beta, 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                                          |

Thiazide diuretics are prone to hypokalemia, metabolic disorders (hyperglycemia, hyperuricemia with gout attacks), lipid disorders, photosensitization, erectile dysfunction, hypochloremic alkalosis. These diuretics expose to gynecomastia.
### Table: Examples of Pharmacological Stems

<table>
<thead>
<tr>
<th>Stem</th>
<th>Definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-tiazem</td>
<td>Calcium channel blockers, diltiazem derivative</td>
<td>diltiazem</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-pamil</td>
<td>Calcium channel blockers, verapamil derivatives</td>
<td>verapamil*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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 |

- cetrade | Cholesteryl ester transfer protein (CETP) inhibitors | forctrapid | 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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-arotene</td>
<td>Arotinoid derivatives</td>
<td>betacarotene</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-retin</td>
<td>Retinol derivatives</td>
<td>tretinoin</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-erg</td>
<td>Ergot derivatives</td>
<td>ergometrine*</td>
<td>ergocalciferol (vit D precursor)</td>
<td>rotigotine</td>
</tr>
<tr>
<td>-golide</td>
<td>Dopamine receptor agonists, ergoline derivative</td>
<td>pergolide</td>
<td>none</td>
<td>rotigotine</td>
</tr>
</tbody>
</table>

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- compounds) | 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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-begron</td>
<td>Beta, adrenoreceptor agonists</td>
<td>talibegron</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-fenacin</td>
<td>Muscarinic receptors agonists</td>
<td>tofenacin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-afil</td>
<td>Inhibitors of phosphodiesterase PDE5 with vasodilator action</td>
<td>vardenafil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-steride</td>
<td>Testosterone reductase inhibitors</td>
<td>finasteride</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
### H01 PITUITARY AND HYPOTHALAMIC HORMONES AND ANALOGUES

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-relin</td>
<td>Pituitary hormone-release stimulating peptides</td>
<td>leuprolrelin*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-actide</td>
<td>Synthetic pylopeptides with a corticotropin-like action</td>
<td>tetracosactide</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-morelin</td>
<td>Growth hormone release-stimulating peptides</td>
<td>sermorelin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-tirelin</td>
<td>Thyrotropin releasing analogues</td>
<td>protirelin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-pressin</td>
<td>Vasoconstrictors, vasopressin derivatives</td>
<td>desmopressin*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-relix</td>
<td>Gonadotropin-releasing hormone (GnRH) inhibitors, peptides</td>
<td>detirelix</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>cort</td>
<td>Corticosteroids, except prednisolone derivatives</td>
<td>cortisone</td>
<td>clorocortone, difluocortone, fluocortolone, halocortone are prednisolone derivatives</td>
<td>none</td>
</tr>
<tr>
<td>-pred</td>
<td>Prednisone and prednisolone derivatives</td>
<td>prednisolone*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-onide</td>
<td>Steroids for topical use, acetal derivatives</td>
<td>budesonide*</td>
<td>none</td>
<td>amcifanal</td>
</tr>
</tbody>
</table>

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
## ANTINFECTIVES FOR SYSTEMIC USE

**J01 ANTIBACTERIALS FOR SYSTEMIC USE**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-cycline</td>
<td>Antibiotics, protein-synthesis inhibitors, tetracycline derivatives</td>
<td>doxycycline, tetracycline, tigecycline*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-cillin</td>
<td>Antibiotics, 6-aminopenicillanic acid derivatives</td>
<td>benzylpenicillin, cloxacillin*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cef-</td>
<td>Antibiotics, cefalosporanic acid derivatives</td>
<td>cephalaxin, cefazolin, cefepime, cefixime, cefotaxime, cefotaxime, ceftazidime, ceftriaxone*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-bactam</td>
<td>Beta-lactamase inhibitors</td>
<td>sulbactam</td>
<td>none</td>
<td>clavulanic acid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-kacin</td>
<td>Antibiotics, kanamycin and bekamycin derivatives</td>
<td>amikacin*</td>
<td>none</td>
<td>dihydrostreptomycin, streptomycin, apramycin, kanamycin, nebramycin, tobramycin</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sulfa-</td>
<td>Anti-infectives, sulphonamides</td>
<td>sulfapyridine</td>
<td>galsulfase, idursulfase are enzymes and not antibiotics.</td>
<td>many</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-prim</td>
<td>Antibacterials, dihydrofolate reductase(DHFR) inhibitors, trimethoprim derivatives</td>
<td>trimethoprim*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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 effects include deposition in bones and teeth, precluding their use in pregnancy and young children.

Hypersensitivity reactions are by far the most common side effects and these agents are amongst the most common causes of drug allergy.

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.

All aminoglycosides have the potential to produce reversible and irreversible ototoxicity, renal toxicity and neuromuscular blockade.

<p>| sulfa-  | Anti-infectives, sulphonamides                                              | sulfapyridine                 | galsulfase, idursulfase are enzymes and not antibiotics.     | many                                        |
|         |                                                                             |                               |                                                             |                                             |
| -prim   | Antibacterials, dihydrofolate reductase(DHFR) inhibitors, trimethoprim derivatives | trimethoprim*                 | none                                                        | none                                        |</p>
<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-pristin</td>
<td>Antibacterials, streptogramins, protein synthesis inhibitors, pristinamycin derivatives</td>
<td>quinupristin</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-oxacin</td>
<td>Antibacterials, nalidixic acid derivatives</td>
<td>ciprofloxacin, levofloxacin, moxifloxacin, ofloxacin*</td>
<td>none</td>
<td>Flumequine, nalidixic acid, oxolinic acid, pipemidic acid, pirimic acid, metiokate</td>
</tr>
</tbody>
</table>

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**

**Oxazolidinones**

*Linezolid* (WHO model list of essential medicines) is the only INN that belongs to this class.

**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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-conazole</td>
<td><strong>Systemic antifungal agents, miconazole derivatives</strong></td>
<td>fluconazole, itraconazole, voriconazole*</td>
<td>Bifonazole, isavuconazonium chloride</td>
<td></td>
</tr>
</tbody>
</table>

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*.

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-rifa-</td>
<td><strong>Antibiotics, rifamycin derivatives</strong></td>
<td>rifabutin, rifampicine*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-dapsone</td>
<td><strong>Antimycobacterials, diamino diphenylsulfone derivatives</strong></td>
<td>dapsone*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

**Aminoglycosides**

INNs in this class have no common stem.
**J05 ANTIVIRALS FOR SYSTEMIC USE**

**Anti-herpes virus agents**
No specific stem. *Acyclovir* (WHO model list of essential medicines) belongs to this class.

**Anti-influenza agents**
**Stem –mandadine adamantine derivatives**
This stem is not specific for antiviral agents.

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

**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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-fosfamide</td>
<td>Alkylating agents of the cyclophosphamide group</td>
<td>cyclophosphamide, ifosfamide*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-sulfan</td>
<td>Antineoplastics, alkylating agents, methasulfonates</td>
<td>busulfan</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-tepa</td>
<td>Antineoplastics, thiopeta derivatives</td>
<td>thiopeta</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-mustine</td>
<td>Antineoplastic, alkylating agents, (beta-chloroethyl) amine derivatives</td>
<td>bendamustine*</td>
<td>none</td>
<td>Many INNs</td>
</tr>
<tr>
<td>-platin</td>
<td>Antineoplastic agents, platinium derivatives</td>
<td>carboplatin, cisplatin, oxaliplatin*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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, topoiso merase I inhibitors | irinotecan* | none | none |

| -rubicin | Antineoplastics, daunorubicin derivatives | daunorubcin, daxorubicin* | none | none |
**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.

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-antrone</td>
<td>Antineoplastics, anthraquinone derivatives</td>
<td>mitoxantrone</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-bulin</td>
<td>Antineoplastics, mitotic inhibitors, tubulin binders</td>
<td>mivobulin</td>
<td>thyroglubulin</td>
<td>none</td>
</tr>
</tbody>
</table>

Tubulin binders commonly cause peripheral neuropathy

<table>
<thead>
<tr>
<th>mito-</th>
<th>Antineoplastics, nucleotoxic agents</th>
<th>mitogillin, mitopodozide, mitotenamin</th>
<th>none</th>
<th>none</th>
</tr>
</thead>
<tbody>
<tr>
<td>-parib</td>
<td>Poly-ADP-ribose polymerase inhibitors</td>
<td>olaparib</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-rafenib</td>
<td>Ra(rapidly accelerated fibrosarcoma) kinase inhibitors</td>
<td>sorafenib</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-tansine</td>
<td>Maytansinoid derivatives, antineoplastics</td>
<td>maitansine</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-tinib</td>
<td>Tyrosine kinase inhibitors</td>
<td>erlotinib, gefitinib</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-anib</td>
<td>Angiogenesis inhibitors</td>
<td>vatalanib</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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. *capecitabine* (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**

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

- **L03 IMMUNOSTIMULANTS**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-stim</td>
<td>Colony stimulating factors</td>
<td>filgrastim*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-imod</td>
<td>Immunomodulators, both stimulant/ suppressive and stimulant</td>
<td>tiprotimod</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
■ **L04 Immunostimulants**

*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 ANTIARHEUMATIC PRODUCTS

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ac</td>
<td>Anti-inflammatory agents, ibufenac derivatives</td>
<td>diclofenac</td>
<td>none</td>
<td>amtometin guacil, clamidoxic acid, fenclozic acid, metiazinic acid, prodolic acid, tolmetin</td>
</tr>
<tr>
<td>-fenamic</td>
<td>Anti-inflammatory anthranilic acid derivatives</td>
<td>clofenamic acid, flufenamic acid, mfenamic acid</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-fenamate</td>
<td>Fenic acid derivatives</td>
<td>cofenamate, etofenamate</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-coxib</td>
<td>Selective cyclooxygenase inhibitors</td>
<td>celecoxib, deracoxxib, parecoxxib, rofecoxxib, valdecoxxib</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

Selective COX-2 inhibitors are associated with a lower incidence of serious gastrointestinal effects than the traditional NSAIDS but they can induce severe cardiovascular 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. *allopurinol* (WHO model list of essential medicines) belongs to this class.

- **M05 DRUGS FOR TREATMENT OF BONE DISEASES**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-dronic acid</td>
<td>Calcium metabolism regulators, pharmaceutical aid</td>
<td>zoledronic acid</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

  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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-flurane</td>
<td>Halogenated compounds used as general inhalation anesthetics</td>
<td>halothane*</td>
<td>apafurane</td>
<td>fluoxene, halothane</td>
</tr>
<tr>
<td>-caine</td>
<td>Local anesthetics</td>
<td>bupivacaine, lidocaine, tetracaine*</td>
<td>none</td>
<td>dyclonine</td>
</tr>
</tbody>
</table>

### N02 ANALGESICS

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-orphan, -orph-, -orphinol-, orphone</td>
<td>Opioid receptor antagonists/agonists, morphinan derivatives</td>
<td>morphine*</td>
<td>emorphazone (anti-inflammatory), orphenadrine (antiparkinsonian)</td>
<td>none</td>
</tr>
<tr>
<td>-azocine</td>
<td>Narcotic antagonists/agonists related to 6,7-benzomorphan</td>
<td>phenaazocine</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-adol</td>
<td>analgesics</td>
<td>acetyl-</td>
<td>alfadolone (general anesthetic), nadolol (beta blocker), quinestradol (estrogen)</td>
<td>none</td>
</tr>
<tr>
<td>-fentanil</td>
<td>Opioid receptor agonists, analgesics, fentanyl derivatives</td>
<td>fentanyl*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>stem</td>
<td>definition</td>
<td>Example</td>
<td>INN with this stem belonging to another pharmacological class</td>
<td>INN belonging to this class without the stem</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>nal-</td>
<td>Opioid receptor antagonists/agonists related to normorphine</td>
<td>naxalone*</td>
<td>nalidixic acid (antibacterial)</td>
<td>none</td>
</tr>
<tr>
<td>-triptan</td>
<td>Serotonin (5HT₁), receptor agonists, sumatriptan derivatives</td>
<td>oxitriptan</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-toin</td>
<td>Antiepileptics, hydantoin derivatives</td>
<td>phenytoin*</td>
<td>nitrofurantoin (antibacterial)</td>
<td>none</td>
</tr>
</tbody>
</table>

Gingival hypertrophy is a classic side effect of hydantoins.

| -ampanel | Antagonists of the ionotropic non-NMDA (N-methylD-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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-golide</td>
<td>Dopamine receptors agonists, ergoline derivative</td>
<td>pergolide</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-peridol</td>
<td>Antipsychotics, haloperidol derivatives</td>
<td>haloperidol</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

*haloperidol* derivatives do not induce atropinic side effects.

| -peridone | Antipsychotics, risperidone derivatives | risperidone* | none | none |

Benzodiazepine were widely used until 1980 years when tolerance and dependence, amnesia/automatism phenomena were described.

| -azepam | Diazepam derivatives | diazepam, lorazepam* | 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

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-pramine</td>
<td>Substances of the imipramine group</td>
<td>clomipramine*</td>
<td>none</td>
<td>Carbamazepine, opipramol</td>
</tr>
<tr>
<td></td>
<td><strong>Atropinic side effects is the major toxicity of imipraminics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-triptyline</td>
<td>Antidepressants dibenzo[a,d] cyproheptane or cycloheptene derivatives</td>
<td>amitriptyline*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td><strong>Atropinic side effects is the major toxicity of these substances</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-traline</td>
<td>Serotonin reuptake inhibitors</td>
<td>sertraline</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-oxetine</td>
<td>Serotonin and/or norepinephrine reuptake inhibitors, fluoxetine derivatives</td>
<td>fluoxetine</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td><strong>All serotonin reuptake inhibitors can induce paradoxical aggressivity and enhance suicidal risk. Nausea, vomiting and other gastro intestinal disturbances are frequent.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-fensine</td>
<td>Norepinephrine, serotonin, dopamine reuptake inhibitors</td>
<td>nomifensine</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

### N07 OTHER NERVOUS SYSTEM DRUGS

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-meline</td>
<td>Cholinergic agents (muscarine receptor agonists/partial antagonists used in treatment of Alzheimer's disease)</td>
<td>xanomeline</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-lisant</td>
<td>Histamine H&lt;sub&gt;1&lt;/sub&gt; receptor antagonists</td>
<td>cipralisant</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-nidazole</td>
<td>Antiprotozoals and radiosensitizers metronidazole derivatives</td>
<td>metronidazole, miconazole*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

Azole derivatives are metabolized by cytochrome P450-dependent enzymes, which leads to many drug interactions.

**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**

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-antel</td>
<td>Antihelminthics</td>
<td>praziquantel*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-bendazole</td>
<td>Antihelminthics, tiabendazole derivatives</td>
<td>albendazole, benznidazole, mebendazole, triclabendazole*</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-ectin</td>
<td>Antiparasitics, ivermectine derivatives</td>
<td>ivermectine*</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
# RESPIRATORY SYSTEM

## R03 DRUGS FOR OBSTRUCTIVE AIRWAY DISEASES

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-terol</td>
<td>Bronchodilators, phenylethylamine derivatives</td>
<td><em>amiterol, fenoterol, rimiterol</em></td>
<td>none</td>
<td><em>isoetarine, methoxyphenamine, salbutamol, salmefamol, terbutaline</em></td>
</tr>
<tr>
<td>-trop-</td>
<td>Atropine derivatives</td>
<td><em>eucatropine</em></td>
<td><em>somatropin, somatropin pegol, varifollitropin alfa</em></td>
<td>none</td>
</tr>
<tr>
<td>-cromil</td>
<td>Antiallergics, cromoglicic acid derivatives</td>
<td><em>terbucromil</em></td>
<td>none</td>
<td><em>cromoglicate</em></td>
</tr>
<tr>
<td>-ast</td>
<td>Antiamathics or antiallergics, not acting primarily as antihistaminics</td>
<td><em>loxanast, tranilast, zaprinast</em></td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>-lukast</td>
<td>Leukotriene receptor antagonists</td>
<td><em>tomelukast</em></td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

## R06 ANTIHISTAMINES FOR SYSTEMIC USE

<table>
<thead>
<tr>
<th>stem</th>
<th>definition</th>
<th>Example</th>
<th>INN with this stem belonging to another pharmacological class</th>
<th>INN belonging to this class without the stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>-astine</td>
<td>antihistaminics</td>
<td><em>moxastine, perastine</em></td>
<td><em>vinblastine (cytostatic)</em></td>
<td><em>astemizole</em></td>
</tr>
</tbody>
</table>

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