

International Code of Nomenclature of Prokaryotes

Appendix 9: Orthography

[Written on behalf of the Judicial Commission (JC) of the International Committee on Systematics of Prokaryotes (ICSP) by Hans G. Trüper in cooperation with Jean P. Euzéby. Accepted at the Plenary Meetings of the JC and the ICSP during the IUMS Congress in San Francisco, CA, USA, July 23-29, 2005]

Preamble: When naming an organism authors should be aware of the fact that there is no guarantee that all strains of a newly named species or all species of a newly named genus possess the property or properties used for the formation of that name.

A. Formation of Compound Names

(1) Compound names are formed by combining two or more words or word elements of Latin and/or Greek origin into one generic name or specific epithet. In most cases two word elements are used (e.g.: *Thio/bacillus*, *thio/parus*), but up to four elements may be found (e.g.: *Ecto/thio/rhodo/spira*). The combination of word elements follows four basic rules:

- (a) Except for the last word element only the word stems are to be used.
- (b) The connecting vowel is -o- when the preceding word element is of Greek origin, it is -i- when the preceding word element is of Latin origin. Greek is more flexible than Latin about the connecting vowel, and other connecting vowels than -o- may be used if a precedent is found in Greek. <Example: *Corynebacterium* >.
- (c) A connecting vowel is dropped when the following word element starts with a vowel.
- (d) Hyphens and diacritic signs are not allowed (cf. Rule 12a and 64, respectively).

(2) Exemptions from these regulations exist only for the following cases:

- (a) When well established word elements from chemistry or physics are used, their use in these sciences must be followed.
< Example: Thio- for sulfur does not lose the -o- in combinations: *Thioalkalibacter*, *thiooxidans* (following the usage in chemistry: thioether, thioester); likewise radio- would not lose the -o- in combinations such as “*Radioalkalibacter*” or “*radioegens*” (following the usage in physics: radioactive)>
- (b) As in inorganic chemistry the vowels -o and -i are used to indicate different oxidation levels of cations (e.g. ferro, ferri, cupro, cupri etc.), they do not fall under the Greek/Latin ruling for connection vowels when used in prokaryote names.
<Examples: *Ferroglobus* is a Fe²⁺ oxidizer, while *Ferrimonas* is a Fe³⁺ reducer>
- (c) In word components like bio-, geo-, halo-, neo-, macro-, micro-, etc. the connecting vowel -o- may be kept when a component follows that begins with a vowel (for reasons of clarity or of previous usage).

B. Generic (and subgeneric) names

(1) The name of a genus (or subgenus) is a Latin noun (substantive) in the nominative case. If adjectives or participles are chosen to form generic names they have to be transformed into substantives (nouns) and handled as such. In some cases the substantivation has already happened in classical Latin (e.g. *Serpens*).

<Examples:

- a) genuine nouns: *Bacillus*, *Streptococcus*, *Escherichia*, *Azotobacter*;
- b) substantivated adjectives: *Ammoniphilus*, *Halorubrum*, *Methanosalsum*, *Rubritepida*;
- c) substantivated participles of the present: *Agarivorans*, *Myceligeners*, *Serpens*;
- d) substantivated participles of the perfect: *Amycolata*, *Aquiflexum*, *Gemmata*,
Microlunatus, *Pectinatus*.>

(2) Both Latin and Greek know three genders, i.e. contain nouns of masculine, feminine and neuter gender. Adjectives associated with nouns follow these in gender. For the correct formation of specific epithets (as adjectives) it is therefore necessary to know the gender of the genus name or of its last component, respectively.

< Examples for some last components in compound generic names are:

of masculine gender : *-arcus*, *-bacillus*, *-bacter*, *-coccus*, *-ger*, *-globus*, *-myces*, *-philus*, *-planes*, *-sinus*, and *-vibrio*.

of feminine gender: *-arcula*, *-cystis*, *-ella*, *-ia*, *-illa*, *-ina*, *-musa*, *-monas*, *-opsis*, *-phaga*, *-pila*, *-rhabdus*, *-sarcina*, *-sphaera*, *-spira*, *-spina*, *-spora*, *-thrix* and *-toga*;

of feminine or masculine gender: *-cola* (*-incola*);

of neuter gender: *-bacterium*, *-bactrum*, *-baculum*, *-filamentum*, *-filum*, *-genium*, *-microbium*, *-nema*, *-plasma*, *-spirillum*, *-sporangium* and *-tomaculum*.

of masculine or feminine or neuter gender: *-ferax*, *-fex*, and *-vorax*.>

(3) The gender of a new genus must be indicated with the etymology given in the description.

C. Specific (and subspecific) epithets

(1) Rule 12c of the Code demands that specific (or subspecific) epithets must be treated in one of the three following ways:

- (1) as an adjective that must agree in gender with the generic name
- (2) as a substantive (noun) in apposition in the nominative case
- (3) as a substantive (noun) in the genitive case.

< Examples: (a) *Staphylococcus aureus* (adjective: “golden“), (b) *Desulfovibrio gigas* (nominative noun: “the giant“), (c) *Escherichia coli* (genitive noun: “of the *colum* = colon“)>

(2) Adjectives and participles as specific epithets:

- (a) Latin adjectives belong to the 1st, 2nd and 3rd declension. Those of the 1st and 2nd declension have different endings in the three genders. In the 3rd declension the situation is more complicated, as there are adjectives that don't change with gender, others that do and such that are identical in the masculine and feminine gender and different in the neuter.

Table 1 gives some respective examples. Note that also comparative adjectives are listed. It is recommended to always look up an adjective in the dictionary before using it for the formation of a name.

Table 1. Examples of Latin adjectives

<u>Masculine</u>	<u>Feminine</u>	<u>Neuter</u>	English translation
1st and 2nd declension			
* <i>bonus</i>	<i>bona</i>	<i>bonum</i>	good
* <i>aureus</i>	<i>aurea</i>	<i>aureum</i>	golden
<i>miser</i>	<i>misera</i>	<i>miserum</i>	wretched
<i>piger</i>	<i>pigra</i>	<i>pigrum</i>	fat, lazy
<i>ruber</i>	<i>rubra</i>	<i>rubrum</i>	red
<i>pulcher</i>	<i>pulchra</i>	<i>pulchrum</i>	beautiful
3rd declension			
<i>puter</i>	<i>putris</i>	<i>putre</i>	rotten
<i>celer</i>	<i>celeris</i>	<i>celere</i>	rapid
* <i>facilis</i>	<i>facilis</i>	<i>facile</i>	easy
<i>facilior</i>	<i>facilior</i>	<i>facilius</i>	easier
<i>maior</i>	<i>maior</i>	<i>maius</i>	more
<i>minor</i>	<i>minor</i>	<i>minus</i>	less
<i>simplex</i>	<i>simplex</i>	<i>simplex</i>	simple
<i>egens**</i>	<i>egens</i>	<i>egens</i>	needy

* most common types; ** an infinitive participle used as adjective.

- (b) Participles are treated as if they are adjectives, i. e. they fall under Rule 12c, (2), of the Code .
- (c) Infinitive (also named “present“) participles in the singular do not change with gender. According to the four conjugations of Latin they end on *-ans* (first conjugation, e.g. *vorans* devouring, from *vorare* to devour, *voro* I devour), *-ens* (second conjugation, e.g. *inhibens* inhibiting, from *inhibere* to inhibit, *inhibeo* I inhibit), *-ens* (third conjugation, e.g. *exigens* demanding, from *exigere* to demand, *exigo* I demand), *-iens* (third conjugation, e.g. *faciens*, from *facere* to make, *facio*, I make), *-iens* (fourth conjugation, e.g. *oboediens*, from *oboedire* to obey, *oboedio* I obey). Note, that the knowledge of the ending of the first person singular in the present is decisive!
- (d) Perfect participles change their endings with gender and are handled like adjectives of the first and second declension, e.g., *aggregatus* (masc.), *aggregata* (fem.), *aggregatum* (neut.) (aggregated, from *aggregare* to get together), *flexus*, *flexa*, *flexum*

(bent, from *flectere* to bend), *latus, lata, latum* (carried, from the irregular verb *ferre* to carry), *diminutus, diminuta, diminutum* (smashed, from *diminuere* to smash).

(3) Nominative nouns in apposition as specific epithets

- (a) Nominative nouns in apposition must make sense to be acceptable. In grammar, apposition means “the placing of a word or expression beside another so that the second explains and has the same grammatical construction as the first”; i.e., the added nominative noun has an explanatory specifying function for the generic name, thus, e.g., *Desulfovibrio gigas* may be understood as *Desulfovibrio dictus gigas* and translated as “*Desulfovibrio*, called the giant,“ which - with reference to the unusual cell size of this species - makes sense.
- (b) All specific epithets ending with the Latin suffixes *-cola* (derived from *incola*, “the inhabitant, dweller“) and *-cida* (“the killer“) fulfill the above-mentioned requirement.

(4) Genitive nouns as specific epithets

- (a) The formation of specific epithets as genitive nouns does not pose problems, as the singular genitive of substantives (nouns) is usually given in the dictionaries.
- (b) If the plural genitive is preferred, as, e.g. in *Lactobacillus plantarum* (“of plants“), one has to find out the declension of the noun, as plural genitives are different in different declensions (cf. below: F (3)).

<Examples: *Curtobacterium plantarum* (first declension), *Staphylococcus equorum* (second declension), *Bifidobacterium dentium* (third declension); examples not yet found of the fourth and fifth declensions>.

D. Formation of prokaryote names from personal names

(1) Persons may be honoured by using their name in forming a generic name or a specific epithet. The Code, however, strongly recommends to refrain from naming genera (and subgenera) after persons that are not connected with bacteriology or at least with natural science (Recommendation 10a) and in the case of specific epithets to ensure that, if taken from the name of a person, it recalls the name of one who discovered or described it, or was in some way connected with it (Recommendation 12c).

(2) It is good style to ask the person to be honoured by a scientific name for permission (as long as she/he is alive). Authors should refrain from naming bacteria after themselves or coauthors after each other in the same publication, as this is considered immodest by the majority of the scientific community [cf. Recommendation 6 (10)].

(3) Personal names in generic names:

- (a) The Code provides two ways to form a generic name from a personal name, either directly by adding the ending *-a*, *-ea*, *-nia* or *-ia* or as a diminutive by adding, usually, the ending *-ella*, *-iella* or *-nella*: Both kinds are always in the feminine gender. Examples are provided in Tab. 2.
- (b) Some personal names in Europe were already latinized before 1800 and kept since. If they end on *-us*, replace the ending by *-a* or *-ella* (diminutive) respectively (e.g., the name Bucerius would result in “*Buceria*“ or “*Buceriella*“). Beware, however, of Lithuanian names like *Didlaukus*, *Zeikus* etc.! These are not latinized but genuine forms and would receive the ending *-ia* according to Table 2.

(c) Not more than one person can be honoured in one generic name or epithet.

Table 2. Ways to form generic names from personal names
(Some names may be hypothetical examples)

Personal name ending on	Add ending	Person	Example (direct formation)	Diminutive ending	Example (diminutive formation)
-a	-ea	da Rocha Lima	<i>Rochalimaea</i>	drop a, add -ella	<i>Rochalimella</i>
-e	-a -ia	Benecke Burke	<i>Beneckea</i> <i>Burkeia</i>	-lla -lla	<i>Beneckella</i> <i>Burkella</i>
-i	-a	Nevski	<i>Nevskia</i>	-ella	<i>Nevskiella</i>
-o	-a -nia	Beggiato Cato	<i>Beggiatoa</i> <i>Catonia</i>	-nella -nella	<i>Beggiatonella</i> <i>Catonella</i>
-u	-ia	Manescu	<i>Manescuia</i>	-ella	<i>Manescuella</i>
-y	-a	Deley	<i>Deleya</i>	-ella	<i>Deleyella</i>
-er	-a -ia	Buchner Lister	<i>Buchnera</i> <i>Listeria</i>	-ella -iella	<i>Buchnerella</i> <i>Listeriella</i>
any consonant	-ia	Cabot Wang Salmon Escherich Zeikus*	<i>Cabotia</i> <i>Wangia</i> <i>Salmonia</i> <i>Escherichia</i> <i>Zeikusia</i>	-(i)ella -(i)ella -ella -(i)ella -(i)ella	<i>Cabot(i)ella</i> <i>Wang(i)ella</i> <i>Salmonella</i> <i>Escherich(i)ella</i> <i>Zeikus(i)ella</i>

* This name of Lithuanian origin is not a genuine latinized name. If it were so, the genus names "Zeikia" or "Zeik(i)ella" might have been possible.

(d) If an organism is named after a person, the name cannot be shortened, e.g.

"Wigglesia" after Wigglesworth, "Stackia" after Stackebrandt or "Goodfellia" after Goodfellow etc., but must fully appear.

Personal titles (*Sir*, *Lord*, *Duke*, *Baron*, *Graf*, *Conte* etc.) are not included in prokaryote names, although they may belong to the name according to the laws of the respective country. Prefixes and particles ought to be treated as follows:

- The Scottish patronymic prefixes "Mac", "Mc", and "M", meaning "son of", should be written "mac" and be united with the rest of the name (e.g. "*Macdonellia*" or "*macdonellii*" after MacDonell; *Macginleya* or *macginleyi* after McGinley).
- The Irish patronymic prefix "O" should be united with the rest of the name or omitted (e.g. "*Oconnoria*" or "*Connoria*" or "*oconnorii*" or "*connorii*" after O'Connor).
- A prefix consisting of an article (e.g. *le*, *la*, *l'*, *les*, *el*, *il*, *lo*, *de*), or containing an article (e.g. *du*, *de la*, *des*, *del*, *della*, *do*, *da*), may be omitted or united to the name (e.g. *Rochalimaea* after da Rocha-Lima; *Leclercia* or "*leclercii*" after Le Clerc; *Leminorella* or *leminorii* after Le Minor; "*Loprestia*" or "*loprestii*" after Lo Presti, *Deleya* or *deleyi* after de Ley, *Devosia* or "*devosii*" after De Vos,).

- The Dutch prefix “van” and the German prefix “von” may be omitted or united to the name (e.g. *Escherichia* after von Escherich; *Leeuwenhoekia* after van Leeuwenhoek, *itersonii* after van Iterson, *prowazekii* after von Prowazek, “*Vannielia*” or *vannielii* after van Niel; “*Vandertoornia*” or “*vandertoornii*” or “*Toornia*” or “*toornii*” after van der Toorn, “*Vandammella*” or “*vandammei*” after Vandamme).
- The adjective Saint (San, Sankt, Santo, -a, Sveti, etc.) as part of some family names may be omitted or united to the name (e.g. “*Exuperya*” or “*exuperyi*” after Saint-Exupéry, “*Sanmartinia*” or “*sanmartinii*” after San Martin).

(e) Rarely, generic names or specific epithets have been formed from forenames (first names, given names, christian names), i.e. not from the family name (examples: *Erwinia* was named after Erwin F. Smith; the first name Arletta appears in *Staphylococcus arlettae* (N.L. gen n. arlettae of Arletta, named after Arlette van de Kerckhove). First names may be chosen in order to avoid rather long family names or unusually long (hyphenated) double names.

(f) In cases of very frequent family names where the honoured person is not easily identifiable, first and family name may be contracted without connecting vowel or hyphenation, but otherwise treated like a single family name.
 < Examples: *Owenweeksia*, *Elizabethkingia* .>

(4) Personal names in specific epithets:

(a) To form specific epithets from personal names there are principally two possibilities: the adjective form and the genitive noun form. The adjective form has no means to recognize the sex of the honoured person, which - in principle - is not necessary for nomenclatural purposes. The personal names receive appropriate endings according to the gender of the generic name as indicated in Table 3. Thus an adjective epithet is formed that has the meaning of “pertaining / relating / belonging to ...(the person)“.

Table 3. Formation of specific epithets from personal names in the adjective form
 (Some names may be hypothetical examples)

Ending of name	of family name	Add the endings for gender		
		<u>masculine</u>	<u>feminine</u>	<u>neuter</u>
consonant	Grant	-ianus	-iana	-ianum
- a	Kondratieva	-nus	-na	-num
-e	Lee	-anus	-ana	-anum
-i	Bianchi	-anus	-ana	-anum
-o	Guerrero	-anus	-ana	-anum
-u	Manescu	-anus	-ana	-anum
-y	Bergey	-anus	-ana	-anum

(b) When the genitive of a latinized personal name is formed for a specific epithet, the sex of the person to be honoured may be taken into consideration as indicated in Table 4. On the basis of classical, medieval and Neo-Latin usage any of the forms of latinization listed in Table 4 may be chosen. As evident from Table 4 the formation of specific epithets from personal names as genitive nouns poses certain problems only with names ending on -a and -o.

(c) The recommendations and rules for genus names as given above [D. (3), (c)-(f)] are as well applicable for specific epithets. Appropriate examples are given there.

Table 4. Formation of specific epithets from personal names as genitive nouns
(Some names may be hypothetical examples)

Ending of name	Add for female	Example, female person	Add for male	Example male person
-a	-e (1 st declension)	Catarina, <i>catarinae</i>	-e (classic)	Komagata, <i>komagatae</i> Volta, <i>voltae</i>
	---	---	-i	Thomalla, <i>thomallai</i>
	-ea	Julia, <i>juliaeae</i>	-ei	Poralla, <i>porallaei</i>
	-iae	Mateka, <i>matekaiae</i>	-ii	Ventosa, <i>ventosaii</i>
-e	-ae	Hesse, <i>hesseae</i>	-i	Stille, <i>stillei</i>
-i	-ae	Kinski, <i>kinskiae</i>	-i	Suzuki, <i>suzukii</i>
-o	-niae	Cleo, <i>cleoniae</i>	-nis	Otto, <i>ottonis</i>
-u	-iae	Feresu, <i>feresuiiae</i>	-ii	Manescu, <i>manescui</i>
-y	-ae	Macy, <i>macyae</i>	-i	Deley, <i>deleyi</i>
-as	drop -as, add -ae	Thomas, <i>thomae</i>	drop -as, add -ae	Cosmas, <i>cosmae</i>
	-iae	Thomas, <i>thomasiae</i>	-ii	Cosmas, <i>cosmasii</i>
-er	-ae	Miller, <i>millerae</i>	-i	Stutzer, <i>stutzeri</i>
				Stanier, <i>stanieri</i>
any other letter	-iae	Gordon, <i>gordoniae</i>	-ii	Pfennig, <i>pfennigii</i> Zeikus, <i>zeikusii</i>

E. Formation of prokaryote names from geographical names

(1) The formation of prokaryote names from geographical names has no geopolitical meaning, i.e., such names cannot be used to express geopolitical claims.

(2) Unlike epithets derived from personal names, epithets on the basis of geographical names cannot be formed as substantives in the genitive case. They must be adjectives and are usually constructed by adding the ending *-ensis* (masculine or feminine gender) or *-ense* (neuter gender) to the geographical name in agreement with the latter's gender. Only if the name of the locality ends on -a or -e or -en these letters are dropped before adding *-ensis/-ense* (e.g., *jenensis* from Jena, *californiensis* from California, *drentensis* from Drente, *bremensis*

from Bremen). If the locality's name ends on –o, the ending becomes –*nensis/-nense* (e.g. the name of the Japanese city Sapporo: *sapporonensis, sapporonense*).

(3) Quite a number of localities in the Old World (Europe, Asia, Africa) have classical Greek, Latin and medieval Latin names and adjectives derived from these: *aegyptius* (Egypt), *africanus* (Africa), *arabicus* (Arabia), *asiaticus* (Asia), *balticus* (Baltic Sea), *bavaricus* (Bavaria), *bretonicus* (Brittany), *britannicus* (Britain), *europaeus* (Europe), *frisius* (Friesland), *gallicus* (France), *germanicus* (Germany), *graecus* (Greece), *hellenicus* (Hellas, classical Greece), *helveticus* (Switzerland), *hibernicus* (Ireland), *hispanicus* (Spain), *hungaricus* (Hungary), *ibericus* (the Spanish/Portuguese = Iberian peninsula), *indicus* (India), *italicus* (Italy), *mediterraneus* (Mediterranean Sea), *persicus* (Persia, Iran), *polonus* (Poland), *rhenanus* (Rhineland), *romanus* (Rome), *saxonicus* (Saxony), etc.. Later, Neo-Latin names were given also to many other non-European parts of the world, so adjectives like *americanus* (America), *antarcticus* (Antarctica), *australicus* (Australia), *cubanus* (Cuba), *mexicanus* (Mexico), *japonicus* (Japan), etc. were introduced. Wherever such older adjectives exist they may be used as specific epithets to indicate geographical origins.

(4) European and mediterranean cities and places of classical times may have had quite different names than nowadays: e.g. *Lucentum* (Alicante, Spain), *Argentoratum* (Strasbourg, France), *Lutetia* (Paris, France), *Traiectum* (Utrecht, Netherlands), *Ratisbona* (Regensburg, Germany), *Eboracum* (York, U.K.), *Londinium* (London, U.K.), *Hafnia* (Copenhagen, Denmark), which lead to the respective adjectives *lucentensis, argentoratensis, lutetiensis, traiectensis, ratisbonensis, eboracensis, londiniensis, hafniensis*, but alternatively, also the Neo-Latin adjectives of the modern names may be used: *alicantensis, strasbourgensis, parisensis, utrechtensis, regensburgensis, yorkensis, londonensis, kopenhagensis*, respectively.

(5) Many localities (mostly lakes, rivers, seas, islands, capes, rocks, mountains or valleys, but also some cities and towns) have names that consist of two words, usually an adjective and a substantive (noun) (e.g. Deep Lake, Black Sea, Red River, Rio Grande, Long Island, Blue Mountain, Baton Rouge, Santa Cruz, Saint Germain, Sankt Georgen etc.), or of two substantives (e.g. Death Valley, Lake Windermere, Loch Ness, Martha's Vineyard, Ayers Rock, Woods Hole, Cape Cod, Monte Carlo etc.). The formation of specific epithets from such localities' names may pose a problem, as the use of the adjectival suffix –*ensis, -ense* may lead to rather strange looking or awkward constructions, such as “*deeplakensis*” or “*bluemountainense*”, although they would be formally correct.. If a name of a locality lends itself to translation into Latin, specific epithets may as well be formed as genitive substantives of the two components and concatenating them without hyphenation, like the existing ones *lacusprofundi* (of Deep Lake), *marisnigri* (of the Black Sea), *marismortui* (of the Dead Sea) or – of two nouns - *vallismortis* (of Death Valley). Note that in Latin the basic noun comes first, the determining word (adjective or noun) second!

(6) The inclusion of articles (such as *the, el, o, il, le, la, a, de, der, die, das, den, het* or their plurals *the, los, las, os, as, les, ils, gli, le, de, die, s'* etc.) as they are used for locations in several languages (e.g., La Paz, El Ferrol, El Alamein, Le Havre, The Netherlands, Die Schweiz, Den Haag, s'Hertogenbosch, Los Angeles etc.) should be avoided. Articles would unnecessarily elongate names without adding information.

F. Formation of names for prokaryotes living in association or symbiosis with other biota

(1) For the formation of names for prokaryotes that live in association or symbiosis with plants, fungi, animals or other prokaryotes it is important to know the exact meaning of the nomenclatural name of such a partner and how they were formed (adjective, genitive noun etc.).

(2) The easiest way of forming such specific epithets is the use of the genitive case of the generic name of the associated organism in question, e.g., *suis*, *equi*, *bovis*, *muscae*, *muris*, *aquilae*, *falconis*, *gypis*, *elephantis* (of the pig, horse, cow, fly, mouse, eagle, falcon, vulture, elephant), or: *fagi*, *quercus* (4th declension genitive, spoken with long u), *castaneae*, *aesculi*, *rosae*, *liliae* (of the beech, the oak, chestnut, horse chestnut, rose, lily).

(3) Alternatively the genitive of the plural is recommendable, especially if several species of the associated (usually) eukaryotic genus house the prokaryote species in question. To form the plural genitive one needs to know stem and declension of the word.

The following examples may be of some principal assistance:

1st declension: *-arum* (*muscarum*, of flies, *rosarum*, of roses)

2nd declension: *-orum* (*equorum*, of horses, *pinorum*, of pines)

3rd declension (consonant stems): *-um* (*leonum*, of lions, *leguminum*, of legumes)

3rd declension (vocal and mixed stems): *-ium* (*felium* of cats; *ruminantium*, of ruminants)

4th declension: *-um* (*quercum*, of oaks)

5th declension: *-rum* (*scabierum*, of different forms of *scabies*, a skin disease)

Be aware of irregular forms such as *bos* (the cow), genitive: *bovis*, plural genitive *bovm*; *canis* (the dog), genitive *canis*, plural genitive *canum*! **Use dictionaries!**

G. Names originating from languages other than Latin or Greek

(1) As the Code defined Latin – or better – Neo-Latin as the language of prokaryote nomenclature, names should not be taken from other languages as long as they may be constructed from Latin or Greek word stems [Recommendation 6 (3)]. Only Latin gender endings are permitted. Greek endings must be transformed into Latin endings.

<Example: The formation of the epithet *simbae* from the East African Swahili word *simba*, lion, for a *Mycoplasma* species was not necessary because in this genus the corresponding Latin epithet *leonis* (of the lion) had not been used before>.

(2) When it becomes unavoidable to use a word from another language the word stem must be identified before latinization.

<Example: The Arabic word “alkali“ (*al-qaliy*, the ashes of saltwort) from which the element kalium (K, English: potassium) received its name. As the -i at the end of the word belongs to the stem it is wrong to speak and write of alcalophilic instead of alkaliphilic microbes>.

(3) Typical usages of the other language should not be carried over into Latin.

<Example: The English suffix -philic (e.g. hydrophilic - friendly to water, water-loving) is an English transformation of the Latin *-philus*, *-a*, *-um* (originating from Greek *philos*, friendly). Therefore the ending *-philicus* must be avoided and *-philus* be used instead >.

(4) National foods or fermentation products (e.g. sake, tofu, miso, yogurt, kvas, kefir, pombe, pulque, aiva etc.) often do not have equivalent Latin names and if typical microorganisms

found in them or causing their fermentations are described, they may be named after them. These names cannot be used unaltered just as specific epithets in the form of nominative substantives in apposition. They are properly latinized by forming a neuter substantive from them by adding *-um* (e.g. *sakeum*, *tofum*, *kefirum*, *pombeum* etc.) and the use of the genitive of that (ending: *-i*) in the specific epithet (e.g. *sakei*, *tofui*, *kefiri*, *pombeii* etc.).

H. Formation of prokaryote names from names of elements and compounds used in chemistry and pharmacy

(1) The vast majority of names of chemicals are latinized as neuter nouns of the 2nd declension with nominatives ending *-um*, genitives in *-i*. The following groups belong into this category:

- (a) Most of the chemical elements with the exception of carbon (L. *carbo*, *carbonis*) phosphorus (L. *phosphorus*, *phosphori*), and sulfur (L. *sulfur*, *sulfuris*) have the ending *-(i)um* with the genitive ending on *-(i)i*; nitrogen may also be called *azotum* besides *nitrogenium*, calcium may also be called *calx* (genitive: *calcis*).
- (b) Names of chemical and biochemical compounds ending on *-ide* (including anions), *-in*, *-ane*, *-ene*, *-one*, *-ol* (only non-alcoholic compounds), *-ose* (sugars), *-an* (polysaccharides), *-ase* (enzymes) are latinized by adding the ending *-um* or by replacing the *-e* at the end by *-um*, respectively).
- (c) Acids are named by *acidum* (L. neuter noun, acid), followed by a descriptive neuter adjective, e.g. sulfurous acid *acidum sulfurosum*, sulfuric acid *acidum sulfuricum*, acetic acid *acidum aceticum*.

(2) The second largest category of chemicals are treated as neuter nouns of the 3rd declension: These are such ending on *-ol* (the alcohols), *-al* (aldehydes), *-er* (ethers, esters), and *-yl* (organic radicals); latinization does not change their names at the end, whereas the genitive is formed by adding *-is*.

(3) Anions ending in *-ite* and *-ate* are treated as masculine nouns of the 3rd declension. The English ending *-ite* is latinized to *-is*, with the genitive *-itis*, e.g. nitrite becomes *nitris*, *nitritis*. The English ending *-ate* is latinized to *-as*, with the genitive *-atis*, e.g. nitrate becomes *nitras*, *nitratris*.

(4) Only few chemicals have names that are latinized in the 1st declension as feminine nouns, ending on *-a* with a genitive on *-ae*. Besides chemicals that always had names ending on *-a* (like *urea*), these are drugs found in classical and medieval Latin, such as gentian (*gentiana*) and camphor (*camphora*), further modern drugs, whose Latin names were formed by adding *-a*, like the French *ergot* becoming *ergota* in Latin. An important group of this category are alkaloids and other organic bases, such as nucleic acid bases and amino acids with English names on *-ine*. In Neo-Latin this ending is *-ina*, with the genitive *-inae*.
<Examples: *betaina*, *-ae*; *atropina*, *-ae*; *adenina*, *-ae*; *alanina*, *-ae* etc.>

(5) Names of pharmaceutical and chemical products or their registered or unregistered trade names are latinized following the instructions given above.

(6) For their use in prokaryote generic names and specific epithets word stems and genitives of latinized chemical names are the basis. In principle they are then treated like any other word elements.

I. Arbitrary names

(1) The basis for arbitrary names are Rules 10a and 12c of the Code: “genus names or specific epithets may be taken from any source and may even be composed in an arbitrary manner“ They must, however, be treated as Latin. Often they are vocalized abbreviations or contractions of names.

< Examples: *Cedecea*, *Afipia*, *Kordia*, *Kribbella*, *Waddlia* and *Desemzia*, that were derived from the abbreviations (or acronyms) CDC (Center for Disease Control), AFIP (Armed Forces Institute of Pathology), KORDI (Korea Ocean Research and Development Institute), KRIBB (Korean Research Institute of Bioscience and Biotechnology), WADDL (Washington Animal Disease Diagnostic Laboratory), DSMZ (Deutsche Sammlung von Mikroorganismen und Zellkulturen), respectively. Another example is *Simkania* (contracted from the name Simona Kahane). Examples for arbitrary specific epithets are, e.g. , (*Burkholderia*) *unamae* derived from the acronym UNAM (Universidad Nacional Autónoma de Mexico), (*Brevundimonas*) *nasdae*, derived from the acronym NASDA (National Space Development Agency of Japan), (*Flavobacterium*) *micromati* derived from the abbreviation MICROMAT (MICROMAT project “Biodiversity of Microbial Mats in Antarctica”).>

(2) When proposing arbitrary names or epithets, authors should aim at short, elegant, easily spelled and pronounced ones.

Note: Also with arbitrary genus names the gender must be indicated !

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