THE SCOPE OF THE FIELD OF HETEROCYCLIC CHEMISTRY

اللهُمَ يا من لا يهزم جنده ولا يخلف وعده ولا إله غيره كُن لأهلنا في غزة عونًا ونصيرً

اللهُم يا مُعلم داوود علّمني ويا مُفهم سليمان فَهمني

- In a 1983 report, the International Union of Pure and Applied Chemistry (IUPAC) recognized 15 elements coming from Groups II to IV of the Periodic System capable of forming cyclic structures with carbon atoms.

١٥ عنصر من عناصر الجدول الدوري
بقدروا يعملوا هياكل حلقية مع
ذرات الكربون

الي هم من المجموعة الثانية للرابعة
١٧ ١١

الاكثر حدوث بالمركبات
النيتروجين > الاكسجين > سلفر

مركبات حلقية غير متجانسة

- Heterocyclic compounds are far from being just the result of some synthetic research effort. Nature abounds in heterocyclic compounds,
- THE SCOPE OF THE FIELD OF HETEROCYCLIC CHEMISTRY many of profound importance in biological processes.
- We find heterocyclic rings in **vitamins, coenzymes, porphyrins (like hemoglobin), DNA, RNA,** and so on.

هاد مكوّن من مكوّنات الـ heme حكينا عنه في البيوكيم

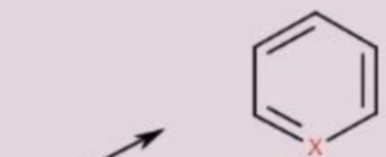
- The plant kingdom contains thousands of nitrogen heterocyclic compounds, most of which are **weakly basic and called alkaloids** (alkali like).
- Complex heterocyclic compounds are elaborated by **microorganisms** and are useful as antibiotics in medicine.
- **Marine animals and plants** are also a source of complex heterocyclic compounds and are receiving much attention in current research efforts.

نباتات وحيوانات بحرية هي مصدر للمركبات الحلقية غير المتجانسة

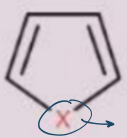
Heterocyclic classification

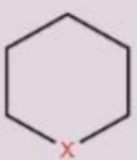
It can be classified into

Heterocyclic compounds



Heterocyclic unsaturated عبارة عن ← Heteroaromatic

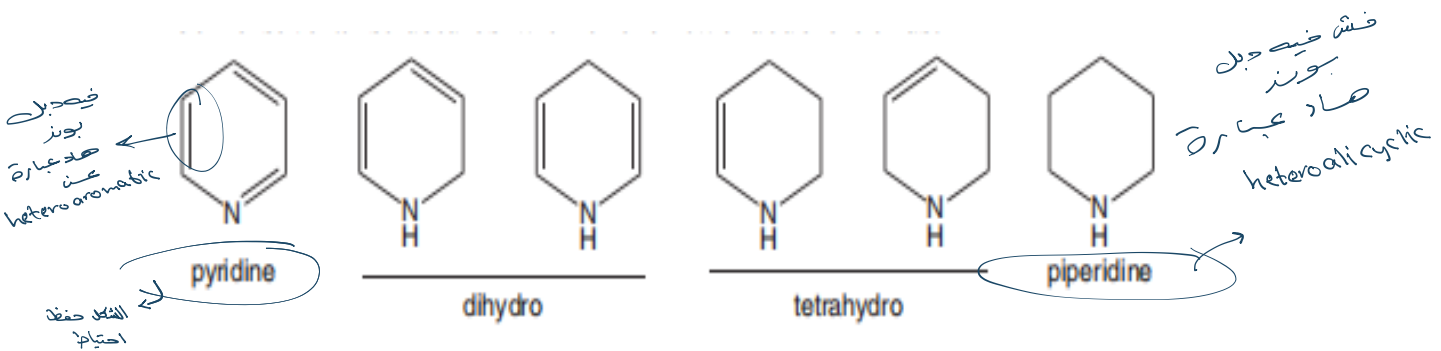




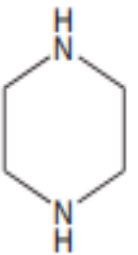
Saturated عبارة عن Heterocyclic ← Heteroalicyclic

The IUPAC rules of nomenclature allow the continued use of well-established common names for some of these fundamental ring systems, but as we will find, there are systematic names also in use for them.

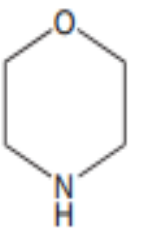
The compound pyridine is an excellent example of a simple heterocycle. Here, one carbon of benzene is replaced by nitrogen, without interrupting the classic unsaturation and aromaticity of benzene. Similarly, replacement of a carbon in cyclohexane by nitrogen produces the saturated heterocycle piperidine. Between these extremes of saturation come several structures with one or two double bonds.



Rings may have more than one heteroatom, which may be the same or different, as in the examples that follow.

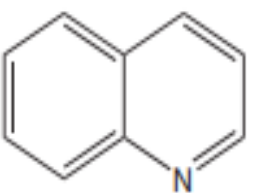


piperazine

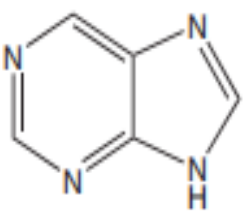


morpholine

To broaden the field, other rings may be fused onto a parent heterocycle. This gives rise to many new ring systems.



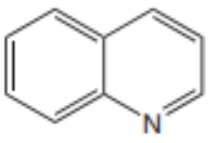
quinoline



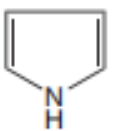
purine

Table 2.1. Some Early Heterocyclic Compounds of Natural Origins

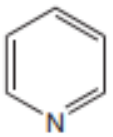
A. Compounds That Are Parent Rings



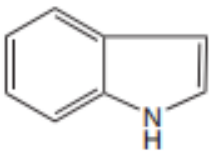
quinoline



pyrrole



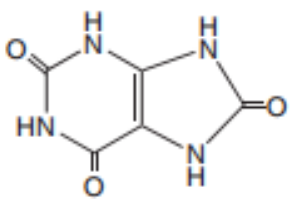
pyridine



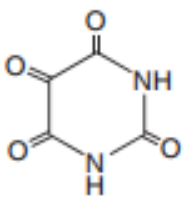
indole

furan

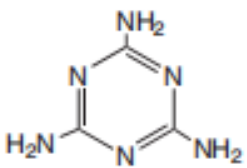
B. Compounds With Functional Groups



uric acid



alloxan



melamine

The IUPAC rules allow three nomenclatures.

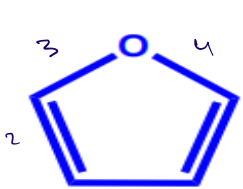
I. The Hantzsch-Widman Nomenclature.

II. Common Names

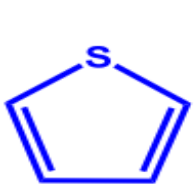
III. The Replacement Nomenclature

II. Common Names

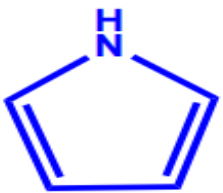
There are a large number of important ring systems which are named widely known with their non-systematic or common names.



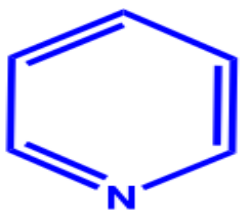
Furan



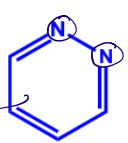
Thiophene



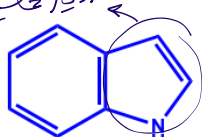
Pyrrole



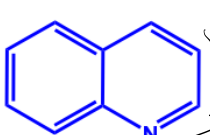
Pyridine



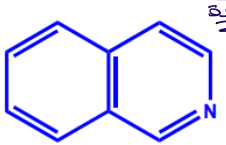
Pyridazine



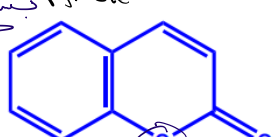
Indole



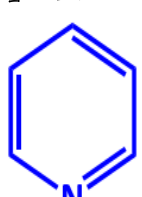
Quinoline



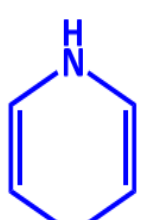
Isoquinoline



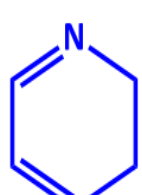
Coumarin



Pyridine

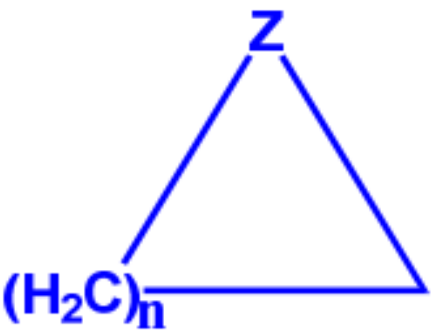


1,4-Dihydropyridine



2,3-Dihydropyridine

I. Hantzsch-Widman Nomenclature



n = 1,2,3, ...

The Hantzsch-Widman nomenclature is based on the type (Z) of the heteroatom; the ring size (n) and nature of the ring, whether it is saturated or unsaturated .

This system of nomenclature applies to monocyclic three-to-ten-membered ring heterocycles.

I. Type of the heteroatom

The type of heteroatom is indicated by a prefix as shown below for common hetreroatoms:

Hetreroatom	Prefix
O	Oxa
N	Aza
S	Thia
P	Phospha

II. Ring size (n)

The ring size is indicated by a suffix according to Table I below. Some of the syllables are derived from Latin numerals, namely ir from tri, et from tetra, ep from hepta, oc from octa, on from nona, ec from deca.

Table I: Stems to indicate the ring size of heterocycles

Ring size	Suffix	Ring size	Suffix
3	ir	7	ep
4	et	8	oc
5	ol	9	on
6	in	10	ec

The endings indicate the size and degree of unsaturation of the ring.

Table II: Stems to indicate the ring size and degree of unsaturation of heterocycles

Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane 	-irine	-iridine
4	-etane 	-ete	-etidine
5	-olane 	-ole	-olidine
6	-inane 	-ine	
7	-epane 	-epine	
8	-ocane 	-ocine	
9	-onane	-onine	
10	-ecane	-ecine	

Oxairane

oxirane ← بنحذف حرف العلة الاول

زي قواعد الانجليزي

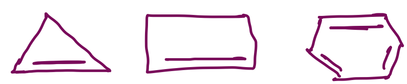
مرضيش علة وري بعض ما يزبط X

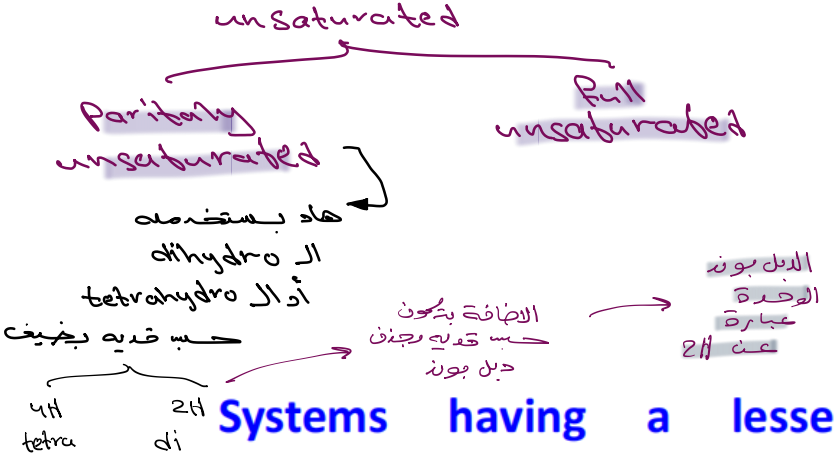
According to this system heterocyles are named by combining appropriate prefix/prefixes with a stem from Table II. The letter "a" in the prefix is omitted where necessary.

Each suffix consists of a ring size root and an ending intended to designate the degree of unsaturation in the ring.

It is important to recognize that the saturated suffix applies only to completely saturated ring systems, and the unsaturated suffix applies to rings incorporating the maximum number of non-cumulated double bonds.

فيها الحد الاقصى من الدبل بوند





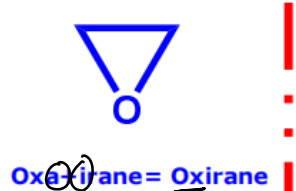
Systems having a lesser degree of unsaturation require an appropriate prefix, such as "dihydro"or "tetrahydro".

Saturated 3, 4 & 5-membered nitrogen heterocycles should use respectively the traditional "iridine", "etidine" & "olidine" suffix.

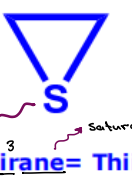
3 4 5

هاي الشيتات حب الجداول
الي فوق
لا تنسى حرفنا علة مرا بعض
ما بصير

Examples



Oxa+irane= Oxirane



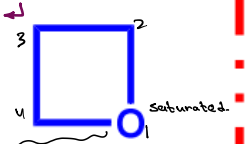
Saturated.

Thia+irane= Thiirane

Saturated with N

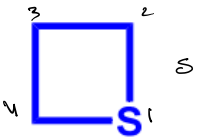
Aza+iridine= Aziridine

لـ حرف علة حب
حرف علة لا يجوز



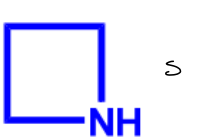
Saturated.

Oxa+etane=Oxetane



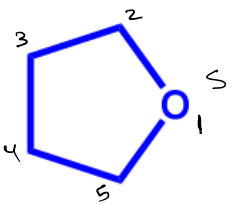
S

Thia+etane=Thietane



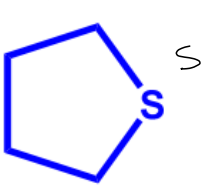
S

Aza+etidine=Azetidine



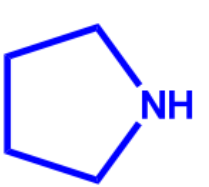
S

Oxa+olane= Oxolane



S

Thia+olane= Thiolane



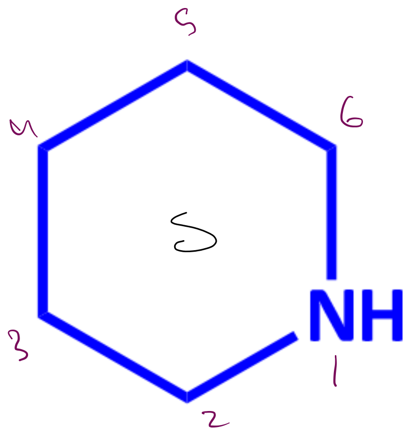
S

Aza+olidine= Azolidine

Saturated : S

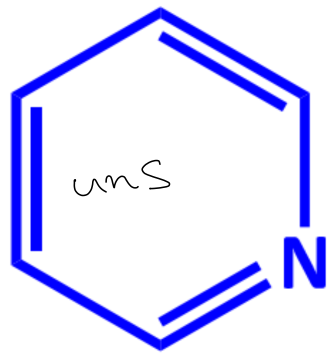
unsaturated : uns

كتير مهم
تميزي بينهم



Azinane

6 — saturated



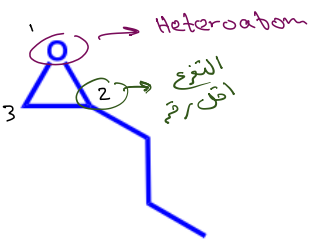
Azaine (a crossed out)

Azine

Pyridine

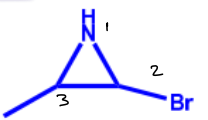
common

In case of substituents, the heteroatom is designated number 1, and the substituents around the chain are numbered so as to have the lowest number for the substituents.



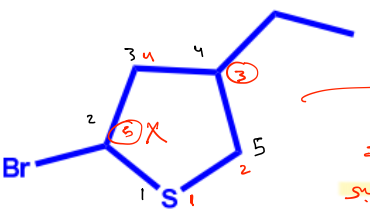
2-Propyloxirane

Oxairane



azaridine

2-Bromo-3-methylaziridine

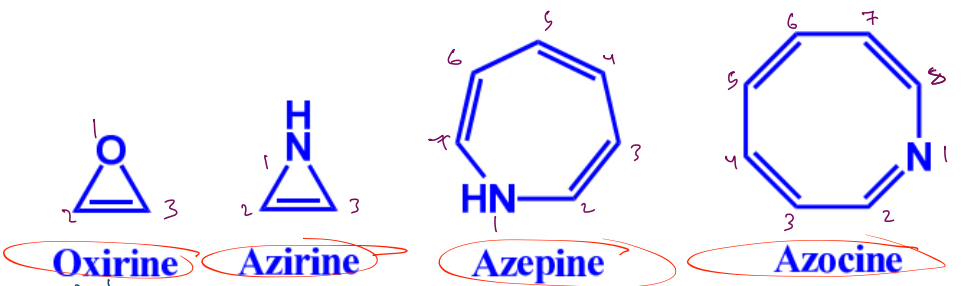


2-Bromo-4-ethylthiolane

دايمًا دايمًا
اذا في عندي
Heteroatom
هي بتوخد رقم ١

لنعرف انه لو
مشبة زي باللون الاحمر غلط
لانه التفرع يكون اخد رقم اكبي
عشان زي اللون
الاسود

The compound with the maximum number of noncumulative double bonds is regarded as the parent compound of the monocyclic systems of a given ring size.



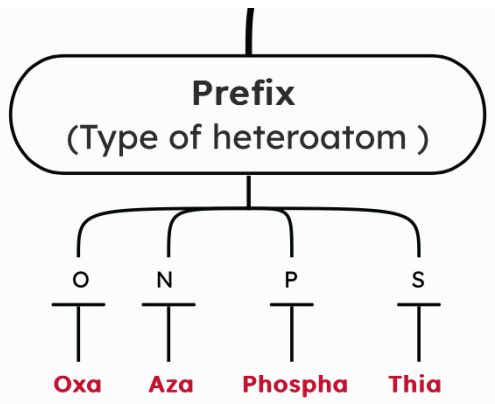
لـ ثلاثية بتعطي
آربطة ثنائية
واحدة

#الدبلغية بتعطي 2 اذا كان
في N اذا كان في O
بتعطي ١

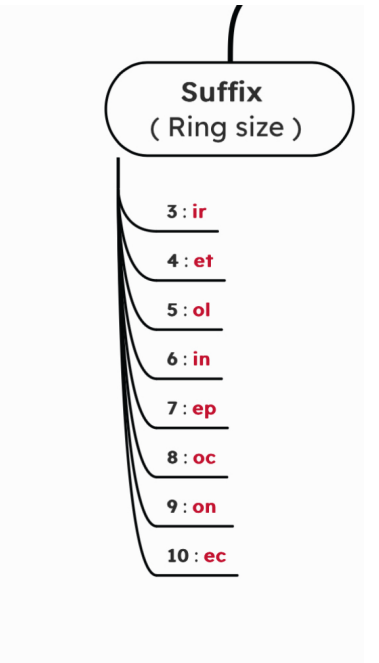
NAMING SIMPLE MONOCYCLIC COMPOUNDS

1. The heteroatom is given a name and is used as a prefix:

- N, aza-;
- O, oxa-;
- S, thia-;
- P, phospha-;
- As, arsa-;
- Si, sila-;
- Se, selena-,
- B,bora
- The “a” ending is dropped if the next syllable starts with a vowel. Thus “aza-irine” is properly written “azirine.”



- 2. Ring size is designated by stems that follow the prefix:
- 3-atoms, -ir-;
- 4-atoms, -et-;
- 5-atoms, -ol-;
- 6-atoms, -in-;
- 7-atoms, -ep-;
- 8-atoms, -oc-;
- 9-atoms, -on-; and so on.



- 3. If fully unsaturated, the name is concluded with a suffix for ring
- size: 3-atoms, -ene (except -ine- for N);
- 4-, 5-, and 6-atoms, -e;
- 7-, 8-, and 9- atoms, -ine.

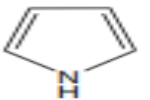
- 4. If fully saturated, the suffix is -ane for all ring sizes,
- except forN, which uses -idine for rings of 3-, 4-, or 5-atoms,
- and for 6-atoms, a prefix of hexahydro- is used.
- Also, the name oxane, not oxinane, is used for the 6-membered ring with O present. Otherexceptions exist for P, As, and B rings, but they will not be given
- here.

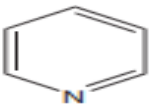
Table 2.2. IUPAC and Common Names for Monocyclic Heterocycles

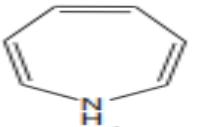
A. Nitrogen Heterocyclic Parents


azirine


azete


azole (pyrrole)


azine (pyridine)

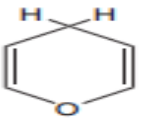

azepine

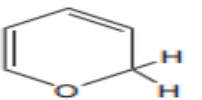
B. Oxygen Heterocyclic Parents


oxirene


oxete


oxole (furan)

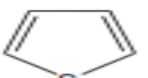

γ-pyran (1,4-pyran)

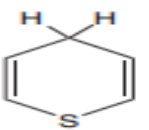

α-pyran (1,2-pyran)

C. Sulfur Heterocyclic Parents


thiirene

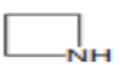

thiete

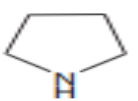

thiole (thiophene)

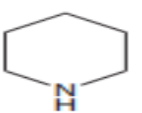

γ-thiopyran

D. Some Saturated Rings


aziridine (ethyleneimine)


azetidine

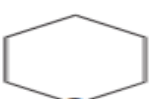

azolidine (pyrrolidine)


hexahydropyridine (piperidine)

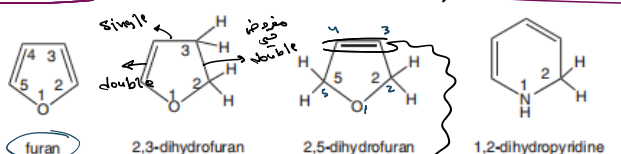

oxirane (ethylene oxide)


oxetane


oxolane (tetrahydrofuran)


oxane (tetrahydropyran)

- saturation of the double bonds by designating with numbers the positions on the ring where hydrogen has been added.
- For this purpose,the heteroatom is designated position 1 on the ring, and the numberingproceeds through the site of hydrogenation.
- If one double bond isremoved, the prefix dihydro- is used;
- with two double bonds removed,it is tetrahydro-.

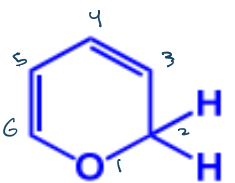


Handling the "Extra Hydrogen"

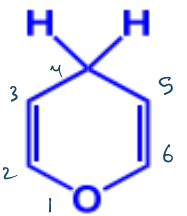
Heterocycles with maximum number of double bonds which can be arranged in more than one way.

Examples

Pyrans



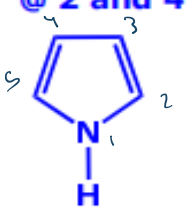
Double bonds @ 2 and 4

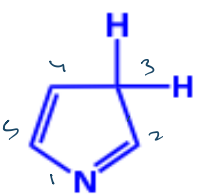


Double bonds @ 2 and 5

Pyrroles

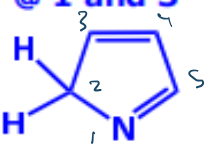
Double bonds @ 2 and 4





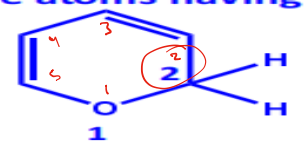
Double bonds @ 1 and 4

Double bonds @ 1 and 3

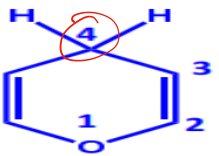


Therefore, should have different names.

This is a special problem resulting from isomerism in the position of the double bonds which is sometimes referred to as "extra-hydrogen" and this can be addressed by simply adding a prefix that indicates the number of the ring atom that possesses the hydrogen using *italic capital '1H' '2H' '3H', etc. The* numerals indicate the position of these atoms having the extra hydrogen atom.

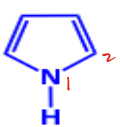


2*H*-Pyran

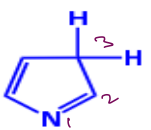


4*H*-Pyran

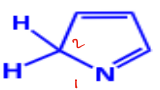
The saturated position takes priority in numbering.



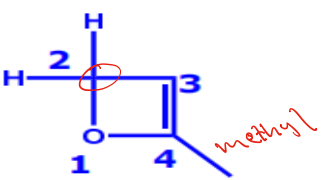
1*H*-Pyrrole (Pyrrole)



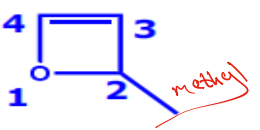
3*H*-Pyrrole



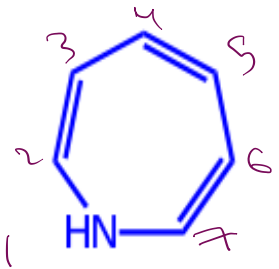
2*H*-Pyrrole



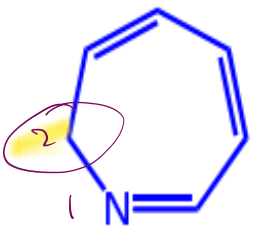
4-Methyl-*2H*-oxete



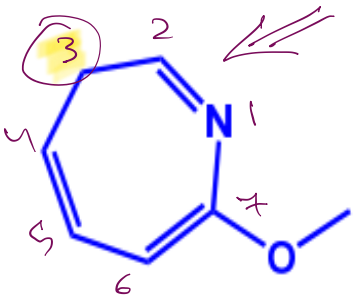
2-Methyl-*2H*-oxete



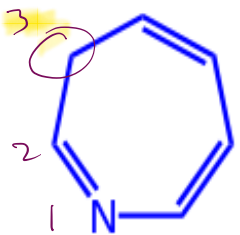
Azepine



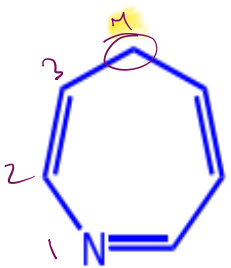
2*H*-Azepine



7-Methoxy-3*H*-azepine



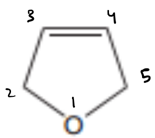
3*H*-Azepine



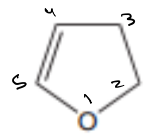
4*H*-Azepine

There is an alternative system, sometimes useful in complex structures, where the position of the remaining double bond in a partially hydrogenated compound is indicated by a Greek “delta” with a superscript of the ring positions bearing the double bond. Using the dihydro furans as examples, we have the following:

هاي لو بدي اسميها بالطريقة الثانية بكون الاسم 2,5-dihydrofuran



$\Delta^{3,4}$-dihydrofuran



$\Delta^{2,3}$-dihydrofuran

هاي لو بدي اسميها بالطريقة الثانية بكون الاسم 2,3-dihydrofuran

اشارة ال Δ معناها الدبل بوند

في طريقتين

احدد مكان الدبل بوند زي فوق

احدد مكان اضافة ال H الي يا بكون

حسب كم دبل بوند حذفت

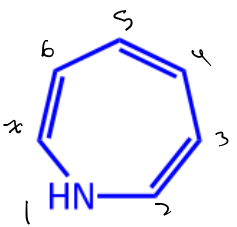
2H بكون حذفت دبل بوند وحدة

4H بكون حذفت 2 دبل بوند

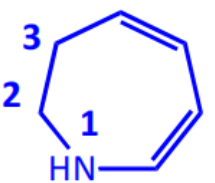
الدبل بوند الوحدة تعبر عن 2H

Partial Unsaturation

Use fully unsaturated name with dihydro, tetrahydro, etc



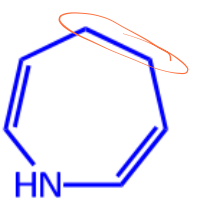
Azepine



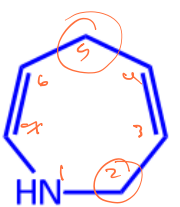
2,3-Dihydroazepine

الحلقة الباعية الحد الاقصى فيها الدبل بوند هو ٣ دبل

تحديد مكان الاضافة

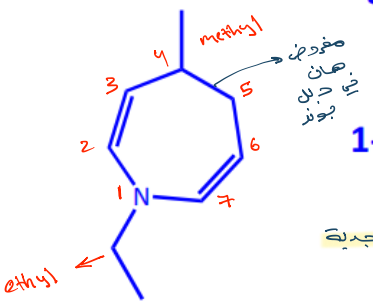


4,5-Dihydroazepine



2,5-Dihydroazepine

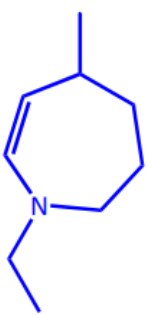
When numbering give priority to saturated atoms.



صفوف هان في حبل جوز

1-Ethyl-4-methyl-4,5-dihydroazepine

الترقيم حسب الاولوية
بالاسم بيجي حسب الابجدية



1-Ethyl-5-methyl-2,3,4,5-tetrahydroazepine

الدكتوره حكت موحفظ

Stems for 3-10 membered heterocycles

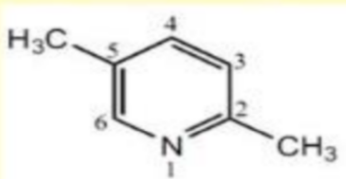
Ring Size	Unsaturation	Saturation
Three	irene(a)	irane(b)
Four -	ete	etane(b)
Five-	ole	olane(b)
Six- A	ine	ane
B	ine	inane
C	inine	inane
Seven-	epine	epane
Eight-	ocine	ocane
Nine-	onine	onane
Ten-	ecine	ecane

Prefixes for heteroatoms (decreasing order of priority)

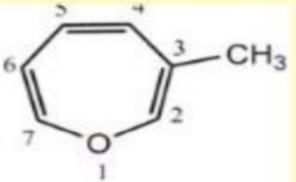
Heteroatom	Valence	Prefix
Oxygen	II	Oxa
Sulfur	II	Thia
Selenium	II	Selena
Tellurium	II	Tellura
Nitrogen	III	Aza
Phosphorous	III	Phospha
Arsenic	III	Arsa
Antimony	III	Stiba
Bismuth	III	Bisma
Silicon	IV	Sila
Germanium	IV	Germa
Tin	IV	Stanna
Lead	IV	Plumba
Boron	III	Bora
Mercury	II	Mercura

Numbering

With one heteroatom: The numbering starts from the heteroatom giving the position-1 and proceeds in such a way as to give the lowest possible locant to the substituent if present.



2,5-Dimethylpyridine



3-Methyloxepine

With two or more identical heteroatoms: The ring is numbered in such a way that the heteroatoms are assigned the lowest possible set of number of locants.

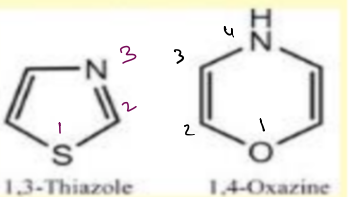
اذا كانوا الهيترو نفس الاشي
يرقم بحيث اعطي اقل رقم

1,3 1,2,4

more than one hetero atom

With two or more different heteroatoms: The numbering starts from the heteroatom with the highest preference as in the table (O>S>N...). The remaining heteroatoms are given lowest number locants.

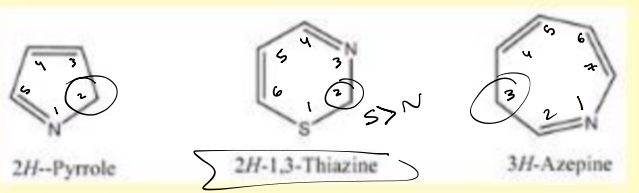
اذا كانوا الهيترو مش نفس
الاشي يرقم حسب الاولوية



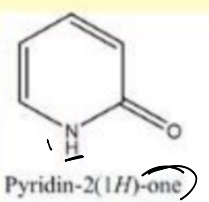
1,3-Thiazole 1,4-Oxazine

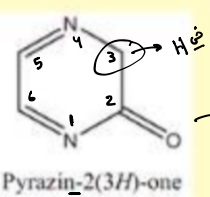
Presence of saturated atom (indicated hydrogen)

- When heterocyclic ring with maximum number of noncumulative double bonds contains a saturated atom, its position is given the lowest possible locant and is numerically indicated by an italic capital *H* before the name of heterocyclic ring system.

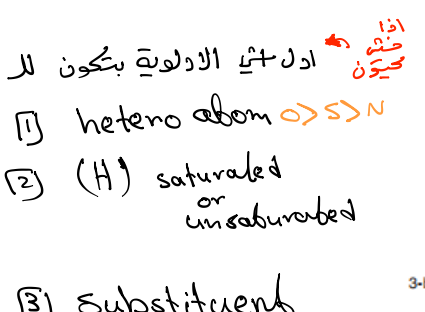


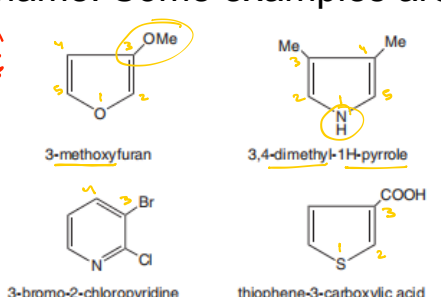
- However, the heterocyclic system in which a carbon atom of the ring is involved in the carbonyl group, the indicated hydrogen is normally cited as an italic capital *H* in parenthesis after the locant of the additional structural features.

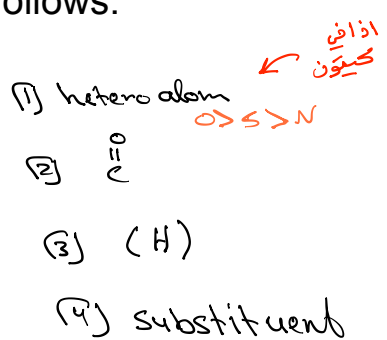




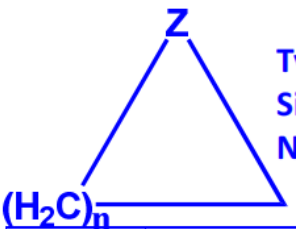
- 2.4. SUBSTITUTED MONOCYCLIC COMPOUNDS
- With the rules discussed previously, we can name any parent monocyclic heterocycle with a single heteroatom, in any state of unsaturation.
- Compounds in which ring hydrogen is replaced by one or more of thecommon functional groups of organic chemistry also are readily named,by assigning numbers to the ring atom(s) bearing the substituents,
- RINGS WITH MORE THAN ONE HETEROATOM starting with the heteroatom as number 1. The functional groups areplaced alphabetically in the name. Some examples are as follows:







Revision



Type (Z) - Prefix
Size (n) - Suffix
Nature of ring - Ending

Hetreroatom	Prefix
O	Oxa
N	Aza
S	Thia
P	Phospha

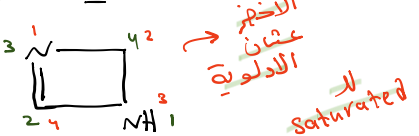
Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane	-irine	-iridine
4	-etane	-ete	-etidine
5	-olane	-ole	-olidine
6	-inane	-ine	
7	-epane	-epine	
8	-ocane	-ocine	
9	-onane	-onine	
10	-ecane	-ecine	

RINGS WITH MORE THAN ONE HETEROATOM

- The usual rules for stems to indicate ring size and suffixes for degree of saturation are used, as are the
- prefixes for the various heteroatoms.
- They are listed in the following order of priorities, derived from the main groups of the Periodic System, and then within each group by increasing atomic number:
- Group VI (O > S > Se > Te) > Group V (N > P > As) > Group IV (Si > Ge) > Group III (B).

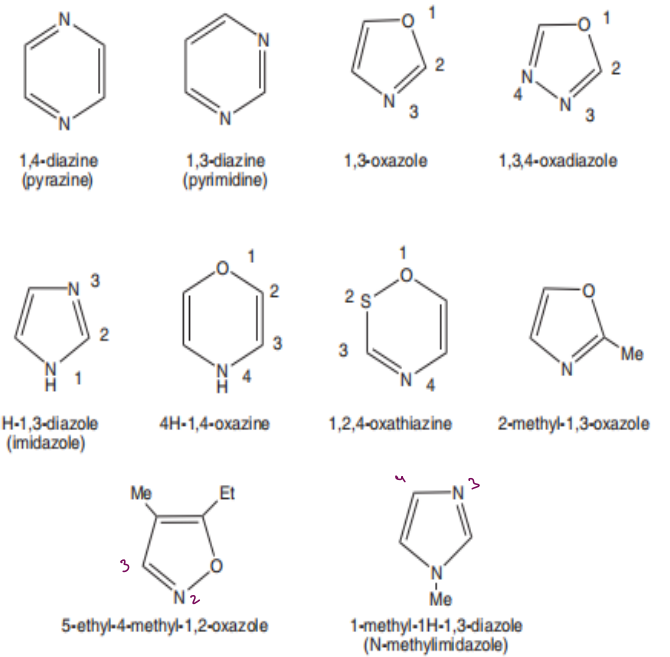
6 > 5 > 4 > 3

- Each heteroatom is then given a number as found in the ring, with that of highest priority given position 1
- A saturated heteroatom with an extra-hydrogen attached is given priority over an unsaturated form of the same atom, as in 1H-1,3-diazole (see the following discussion).
- The numbers are grouped together in front of the heteroatom listings (thus, 1,3-oxazole, not 1-oxa-3-azole).
- The heteroatom prefixes follow the numbers in the priorities given previousl
- Punctuation is important; in the examples to follow, a comma separates the numbers and a dash separates the numbers from the heteroatom prefixes.

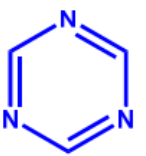


- A slight modification is used when two vowels adjoin; one is deleted, as in the listing for "oxaaza," which becomes simply "oxaza."
- As for monohetero systems, substituents on the ring are listed alphabetically with a ring atom number for each (not grouped together).

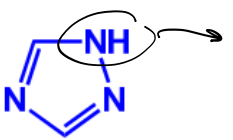
Table 2.3. Some Multiheteroatom Systems



Two or more similar atoms contained in a ring are indicated by the prefixes '*di-*', '*tri*', *etc.*



1,3,5-Triazine

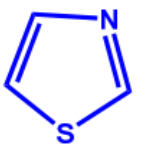


1,2,4 - Triazole

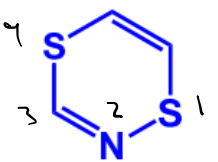
اولويتها اعلى بتاخد رقم ١

If more than one hetero atom occur in the ring, then the heterocycle is named by combining the appropriate prefixes with the ending in Table I in order of their preference, O > S > N.

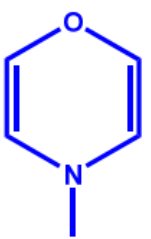
Oxaziridine



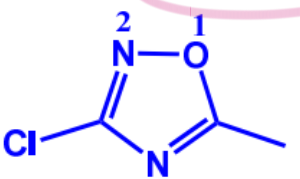
1,3-Thiazole
(Thiazole)



1,4,2 - Dithiazine

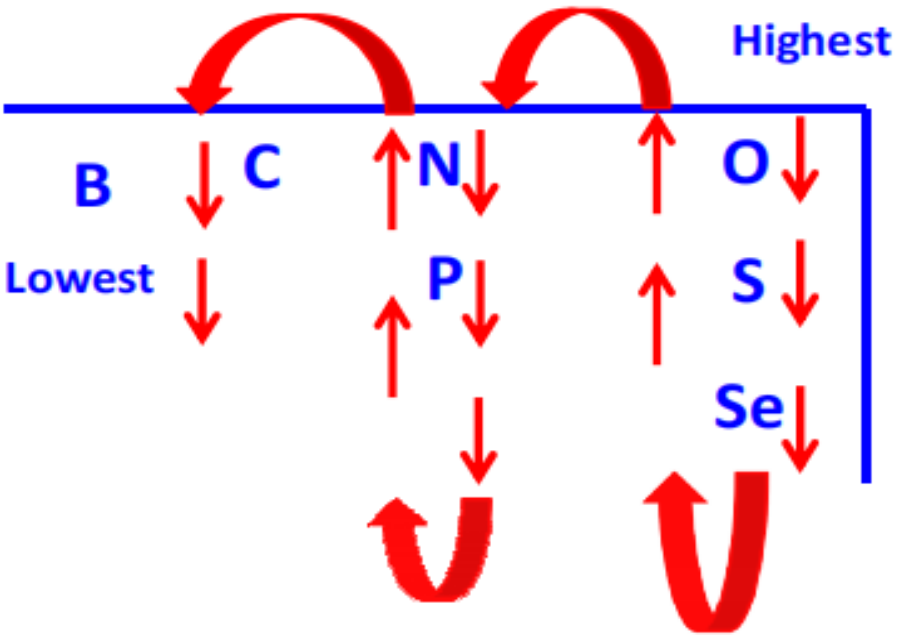


1,4-Oxazine

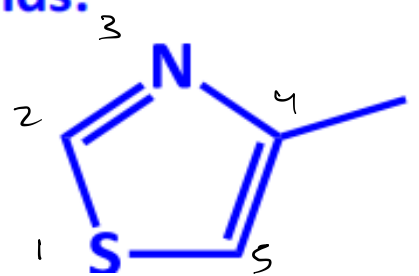


3-chloro-5-methyl-1,2,4-oxadiazole

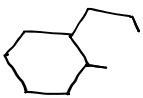
Priority of heteroatoms for numbering purposes:



The ring is numbered from the atom of preference in such a way so as to give the smallest possible number to the other hetero atoms in the ring. As a result the position of the substituent plays no part in determining how the ring is numbered in such compounds.



4-Methyl-1,3-thiazole



BICYCLIC COMPOUNDS

- We next consider systems where two rings share a common
- single or double bond, which are said to be fused rings. A common
- case is where a benzene ring is fused to a heterocyclic ring. The namebegins with the prefix “benzo.”
- The point of attachment is indicated by a letter that defines the “face” of the heterocycle involved. Thus, the 1,2- position on the heterocyclic ring is always the “a-face,” 2,3- is the“b-face,” 3,4- is the “c-face,” and so on. After the name is established,the ring atoms are given new numbers for the entire bicycle.

1, 2 ⇒ a

2, 3 ⇒ b

3, 4 ⇒ c

5, 6 ⇒ D

5, 6 ⇒ E

ابدأ التسمية ←
من عند الذرة الاقرب ال Heteroatom

In Table 2.4 and in subsequent examples, the letters for the faces of the monocycleare placed inside the ring, and the numbers for ring positions of the bicycle taken as a whole are shown on the outside.

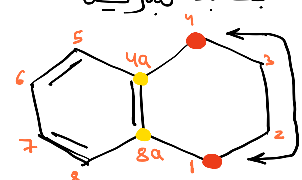
Note that the final numbering always begins **at a position next to the benzo group and that the heteroatoms are given the lowest numbers possible, observingthe O > S > N > P rule.**

The positions of ring fusion bear the number of the preceding ring atom with the letter “a” attached.

Brackets are used around the face letter, and the name is put together without spaces, except that a dash separates the bracket from ring numbers if present, asin benzo[d]-1,3-thiazole.

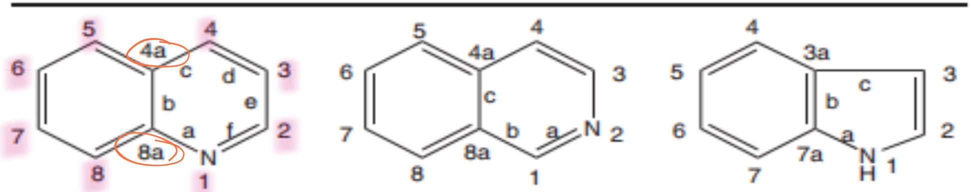
الترقيم يجب ان يبدأ من الذرة التي بجانب البنزين

طيب الي بالأمر شو ارقمه؟
اعطيه الرقم الي قبله + a معاه



اذا كان في ذرة حيترد امشي حسب الاولوية
O > S > N

Table 2.4. Benzo-Fused Systems



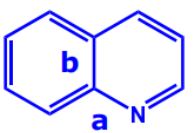
benzo[b]pyridine (quinoline)

benzo[c]pyridine (isoquinoline)

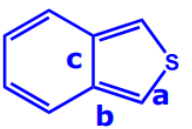
1H-benzo[b]pyrrole (indole)

The name of the heterocyclic ring is chosen as the parent compound and the name of the fused ring is attached as a prefix. The prefix in such names has the ending *'o', i.e., benzo, naphtho and so on.*

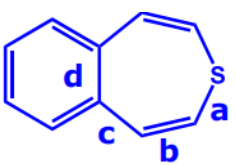
Benzo [b] furan



Benzo [b] pyridine



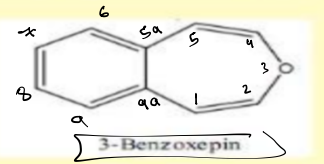
Benzo [c] thiophene



Benzo [d] thiepine

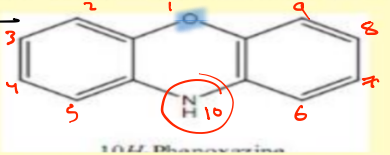
Nomenclature of Benzofused systems:

- If a benzene is fused to the heterocyclic ring, the compound is named by placing number(s) indicating position(s) of the heteroatom(s) before the prefix benzo- (from benzene) followed by the name of the heterocyclic component.



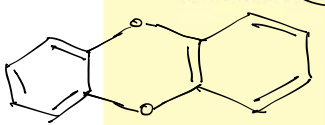
10H-Phenoxazine

However, the heterocyclic system in which two benzene rings are orthofused to a six-membered 1,4-diheteromonocycle containing the same heteroatoms are named by adding the replacement prefix for the heteroatom to the term '-anthrene' replacing 'a'.

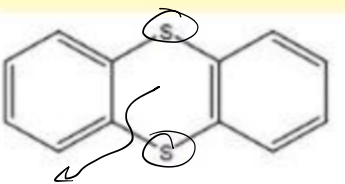


Phenoxazine

- If two benzene rings are ortho-fused to a six membered 1,4-dihetero monocyclic ring containing different atoms, then it is named by adding the prefix 'pheno-' to the H-W name of heterocycle.



→ oxanthrene

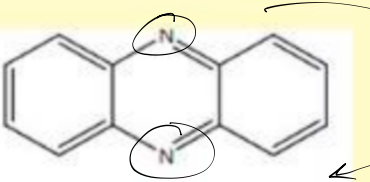


Thianthrene

Thia(anthrene)

Thianthrene

the same



Phenazine

(exception to the rule)

ماعدا استثناء

اذا كانوا 2N بنحط Phenazine

Naming of fused ring systems

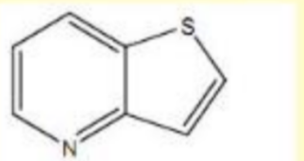
- The fused heterocyclic system is considered to be constructed by the combination of two or more cyclic structural units.
- The cyclic structural units contain maximum number of non-cumulative double bonds and are fused in such a way that each structural unit has one bond common with other.

07:00

- If two heterocyclic rings are fused, additional rules are required.
- A parent ring is selected,
- and the other ring is considered fused on, as was observed for benzene fusion.
- Some rules are as follows:
- If one ring contains N, it is considered the parent, and its name is placed last in the compound's name.
- If both rings contain N, the larger ring is the parent.
- If both rings are of the same size, that with the most N atoms is the parent, or if the same number of N atoms is present, thatfusion of the rings that gives the smallest numbers for N when the bicycle is numbered is chosen.

Selection of base component:

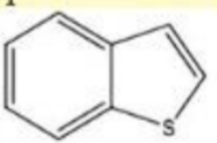
- Nitrogen containing component: a nitrogen containing component is selected as base component.



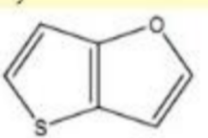
Base component : Pyridine

O > S > N

- If nitrogen is absent, then ring with other heteroatom(s) is selected as base component (order of preference as in the table)

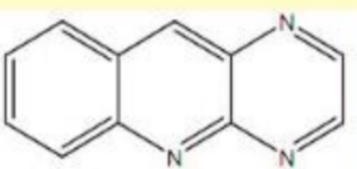


Base component : Thiphene



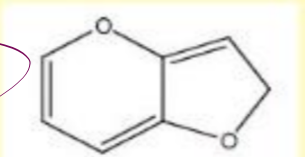
Base component : Furan

- Component with greatest number of rings is selected and named with recognized trivial name if possible.



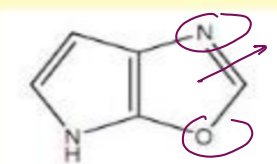
Base component : Quinoline

- If rings of unequal size are present, then the one with largest size of the ring is selecte



Base component : Pyran

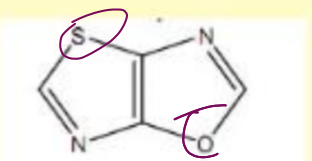
- If rings or equal size with different number of heteroatoms are present, then the ring with greater number of heteroatoms of any kind is considered as a base component.



Base component : Oxazole

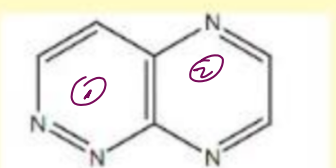
- If rings of equal size with equal number of different heteroatoms are present, then the component containing ring with greatest variety of heteroatoms is selected.

- If two heteroatoms of the same group are present, then components containing heteroatoms appearing first in table is preferred.



Base component : Oxazole

- If rings of same size with same numbers and same kinds of heteroatoms are present, then the component containing the ring with heteroatoms which have lowest locant numbers is preferred.

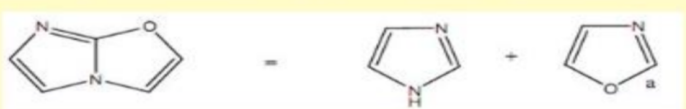


Base component : Pyridazine

المفرع

- The attached component is added as a prefix to the name of the base component. The terminal 'e' is replaced by 'o'.
- The bonds of the base component are alphabetalized with consecutive italic letters starting with '*a*' for 1,2-bond…..
- The atoms are other component are numbered in the normal way 1,2,3….in the principle of lowest possible numbering.

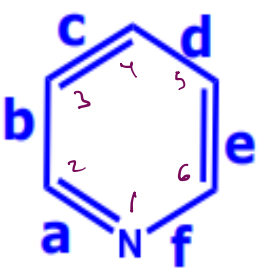
- If a position of fusion is occupied by a heteroatom, both the components (ring systems) are considered to posses that heteroatom.



• If no N is present, O has priority over S over P, and then the above rules are applied.
• The ring fused onto the parent has the suffix “o”; common namesare used (with modification) where possible to simplify the name.
Some examples are pyrido for pyridine, pyrrolo for pyrrole, thieno
for thiophene, furo for furan, imidazo for imidazole, pyrimido for
pyrimidine, pyrazino for pyrazine, among others.

Naming Hetrocycles with fused rings

When naming such compounds the side of the heterocyclic ring is labeled by the letters a, b, c, etc., starting from the atom numbered 1. Therefore side *'a' being between atoms 1 and 2, side 'b' between atoms 2 and* 3, and so on as shown below for pyridine.



Pyridine

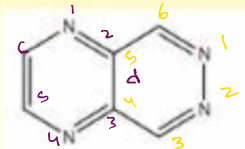
The face letter of the parent ring where the fusion occurs is placed in brackets preceding the name of that ring.

The position numbers of the fused ring are placed inside the brackets before the face letter of the parent ring, separated by a comma.

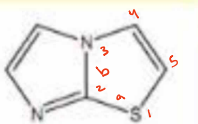
The proper numbers forthe fused ring are those that are encountered as one goes around the ring in the same direction as going alphabetically around the faces of the parent

Numbering of fused systems:

- Fused heterocyclic system is numbered independently of combining components. The numbering is started from the atom adjacent to the bridgehead position with the lowest possible locant(s) to the heteroatom(s). If there is choice, priority is given according to the table.

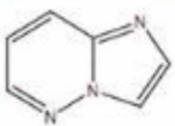


Pyrazino[2,3-*d*]pyridazine



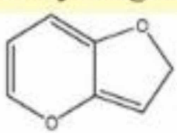
Imidazo[2,1-*b*]thiazole

Carbon atom common to two rings is given the lowest possible position, both not numbered. However, the common heteroatom is numbered.

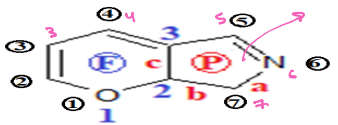


Imidazo[1,2-*b*]pyridazine

The position of a saturated atom is indicated by an italic hydrogen and is given the lowest possible number locant.



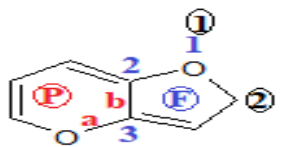
2*H*-Furo[3,2-*b*]pyran



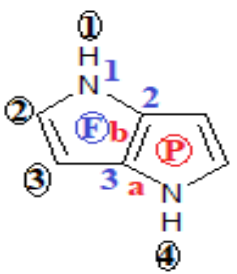
7H- Pyrano[2,3-c]pyrrole

7H-thiopyrano[2,3-b]furan

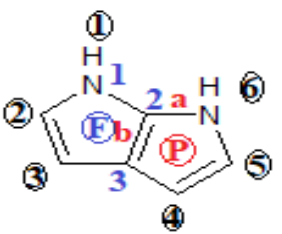
1H-pyrrolo[2,3-b]pyridine



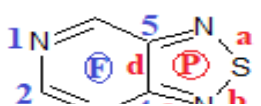
2H-furo[2,3-b]pyr

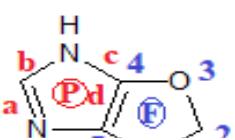


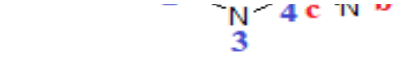
1H,4H-pyrrolo[3,2-b]pyrrole



1H,6H-pyrrolo[2,3-b]pyrrole





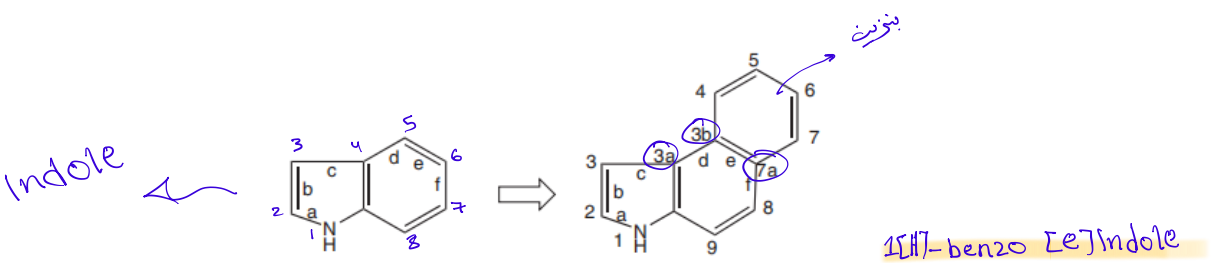


Pyrimido[4,5-d][1,2,5]thiadiazole

2H,4H-1,3-dioxolo[4,5-d]imidazole

MULTICYCLIC SYSTEMS

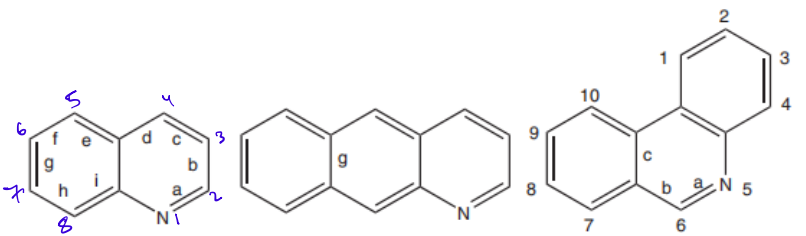
- The general approach is similar to that for bicyclic compounds. Theparent is taken as the largest multicyclic system with a **common name,and then other rings are fused** on as observed in the preceding section.
- The fusion of benzene is illustrated by the compound benzo[e]indole,with indole being the name for the largest heterocycle that can be recognized



indole

1H-benzo[e]indole

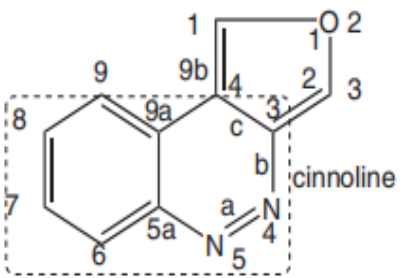
Two of the isomers that can be formed from quinoline are shown as follows:



Numbering the positions of a tricyclic compound always starts at an atom of an outer ring component that is next to a ring fusion and proceeds around that ring.

The starting position is chosen that gives the heteroatoms the lowest possible numbers, as shown forbenzo[c]quinoline. If the numbering had started at the position marked as 10 on this structure, N would have been position 6, not 5.

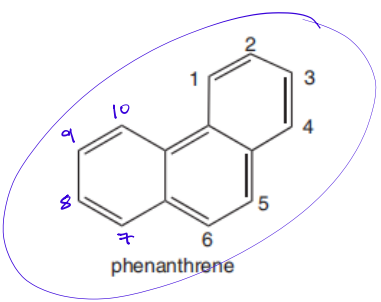
Systems where multiple heteroatom substitution is present are handled by the same general approach as used for bicyclic systems; we find the largest ring system that has a simple name and then specify the point of attachment of other rings. We observe in one example that follows, a fusion of furan at its 3,4- position with the parent cinnoline. As before, the numbers outside the rings are the final numberings for all members of the compound.



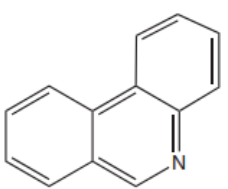
furo[3,4-c]cinnoline

2.8. THE REPLACEMENT NOMENCLATURE SYSTEM

At this point, we can introduce an entirely different system of nomenclature that is nevertheless accepted by IUPAC and is extremely valuable in multicyclic and bridged saturated systems. This is the "replacement system," where the hydrocarbon name that would correspond to the entire ring structure, as if no heteroatom were present, is stated, and then given a Hantzsch–Widman prefix and number for the heteroatom(s). Thus, phenanthridine shown previously has the ring framework of the hydrocarbon phenanthrene, with N at position 5. The replacement name would be 5-azaphenanthrene.



phenanthrene



5-azaphenanthrene

اللهم يا قاضيَّ الحاجات
ويا مجيب الدعوات
ويا مفرج الكربات اجعل لغزة وأهلها من كل ضيق مخرجًا
ومن كل هم فرجًا وكن لهم وليًا ونصيرًا
يارب العالمين.